OpenHIE

OpenHIE Architecture Specification

September 2020

Version 3.0

Contents

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

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1. Background

1.1 Introduction to OpenHIE

OpenHIE is a global mission-driven community of practice dedicated to improving the health of the underserved through open and collaborative development and support of country driven, large scale health information sharing architectures. The OpenHIE community supports interoperability by creating a reusable architectural framework that introduces a service-oriented approach which maximally leverages health information standards, enables flexible implementation by country partners, and supports interchangeability of individual components.

The following specification outlines the reusable architectural practices that constitute OpenHIE. However, the framework is intended to be constantly evolving as standards and implementer needs change over time.

1.2 Purpose of the Specification Release

The purpose of the specification release is to:

- Provide an overview of the OpenHIE Architecture
- Articulate the requirements for OpenHIE components
- Articulate the workflows that are currently recognized as data exchange patterns to follow
- Provide a reference for implementers to use in their architecture and/or implementations

1.3 High-Level Release Process

The process used to update the content was as follows:

1. Subcommunities contributed additions and changes
2. The OpenHIE Architecture Review Board reviewed and approved the content
3. The document was published

The process is expected to evolve in future years.

1.4 Previous Releases

Previous releases of the OpenHIE Architecture Specification are stored on the OpenHIE website.

2. OpenHIE Architecture Introduction

2.1 Purpose of the Architecture

The OpenHIE Architecture is intended to represent a pattern for key architectural components in a health information exchange. The following diagram is a high-level **conceptual diagram,** or logical overview of the OpenHIE architecture that is intended to be notional. This diagram represents the consensus of the OpenHIE Architecture Review Board as determined through the Architecture Governance and Principles. It is expected that implementations based upon OpenHIE may have more precise lower-level conceptual diagrams and/or physical diagrams.

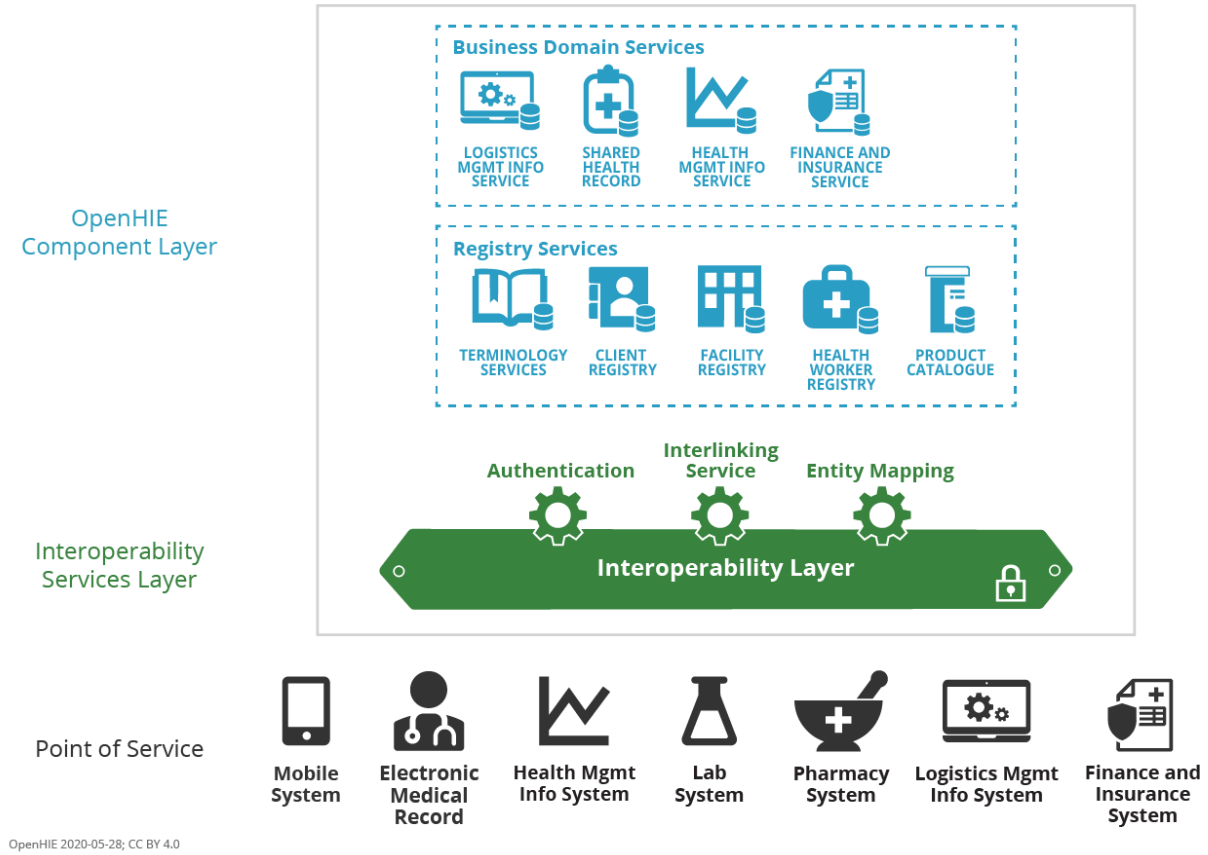


Figure 2.1 - OpenHIE Architecture Diagram

2.2 Overview of the Architecture

A Health Information Exchange (HIE), the shared infrastructure in the large gray box of figure 2.1, makes the sharing of health data across information systems possible. Like a universal translator, an HIE normalizes data and secures the transmission of health information throughout databases, between facilities, and across regions or countries.

OpenHIE's architecture is made up of software components, all interacting/interoperating to ensure that health information from various point-of-service systems is gathered into a health information exchange. To accomplish this, the exchange normalizes the context in which health information is created across multiple dimensions including:

1. Who received health services
2. Who provided the services
3. Where the services were received
4. What particular care and services were received
5. What products may have been involved in treatment
6. Who has financial responsibility

This separation of concerns supports quality, safety, and continuity of care, and facilitates the appropriate use of information needed for population health and metrics calculation.

3. OpenHIE Component Specifications

The purpose of the OpenHIE Component Specification section is to outline what it means to be an OpenHIE Component. (The OpenHIE Components are depicted in the gray box in figure 2.1). Each of the components is defined and requirements and recommendations are documented. Additionally, the non-functional requirements outlined in section 4 of this document are applicable to each OpenHIE Component.

For a software application to meet OpenHIE expectations for a specific component role in OpenHIE, that software must support any "required" workflows and any other "required" functionality.

Definitions:

> **Recommendation:** The recommendation is encouraged and viewed as an important function or workflow that supports OpenHIE goals.
>
> **Requirement:** To qualify as an OpenHIE Component, the required function or workflow must be supported.

3.1 Non-Functional Requirements

The following are recommended non-functional requirements for the OpenHIE component software depicted in the gray box of figure 2.1 and further defined in this document. OpenHIE supports the use of technology that is appropriate for the use case and does not preclude the use of proprietary tools but rather supports the use of tools that are built to meet the needs and support the implementation. OpenHIE does require that technologies do not create a "lock-in" scenario whereby the implementer has no access to their data and as such supports an approach to an open architecture.

#	OpenHIE Non-Functional Requirements	Recommendation/ Requirement
NRF-1	Technologies should provide standard means of accessing data within the system that does not lock the client into proprietary data formats or storage mechanisms.	Recommendation
NFR-2	The system should be well Documented: An OpenHIE reference system should include appropriate background, design, installation, configuration, and operational documentation to ensure it is easy to understand, maintain, and debug. 1. Source code should have comments so that developers do not need to look anywhere else to understand the code. 2. Configuration files should have embedded comments explaining the different options. 3. Installation, configuration, and operational activities should be described.	Recommendation

NFR-3	If the system is an open source tool the system should have open, easy access to source code: A standard version control system (e.g., GitHub) should be used to ensure that source code access is fast, easy to download, compile, and execute code.	Recommendation
NFR-4	The system should be built using common technology: 1. In order to make it easy to run/configure/debug, the software should be built on popular technologies that are widely accepted. 2. Any 3rd party libraries used by the software should be easy for a typical developer to use. 3. Any external software/systems (like the database) should also be easy to use. 4. It should be easy to view the contents of the database.	Recommendation
NFR-5	The source code should include unit tests that are based on the specific requirements of OpenHIE and that create a framework to validate functionality and that the system operates as designed.	Recommendation
NFR-6	OpenHIE does not preclude the use of proprietary solutions. If an open source solution is selected it is recommended that the component would, ideally, be distributed under an OSI approved open-source license that minimizes complexity and enables an implementer community to leverage the software in a broad variety of sustainability contexts.	Recommendation
NFR-7	The system should take into account the IT infrastructure of low resource settings where electricity, internet and/or technical literacy may be limited.	Recommendation

3.2 Client Registry (CR)

The identity of an individual who receives health services is crucial to enabling health care record sharing across institutions and systems. Yet, sharing health care records can be a challenge in a complex environment where there are multiple systems across multiple health care institutions and each institution and/or system has a different way to identify their clients. Even in environments where citizens are assigned national identification cards, there is a need to ensure the unique identity of an individual among the myriad fragmented information systems that collectively represent a person's electronic health record. The Client Registry is designed to assist in uniquely identifying individuals who receive health care services by:

- Maintaining a central registry of all patients and their demographics and assigning a unique identifier to each patient.
- Linking patient registration entries that result due to changes in patient demographics (patient moved to another location), data entry errors during patient registration, or missing demographic information.
- Enabling health care workers to identify facilities at which a patient has received care.

3.2.1 OpenHIE CR Workflow Requirements

A core principle of the OpenHIE architecture is to allow the various infrastructure services (such as the CR) to be interchangeable. To support this, the OpenHIE Standards and Profiles used by the Client Registry are outlined in the workflows below.

To be an OHIE CR component, the CR application must be able to support the OHIE workflows listed below. Implementations may support only the workflows needed to support their use case:

#	CR Workflows (Described in detail in the later part of this document)	Recommendation/Requirement
CRWF-1	A CR shall support the “Create patient demographic record workflow”	Requirement
CRWF-2	A CR shall support the “Update patient demographic record workflow”	Requirement
CRWF-3	A CR shall support the “Query patient demographic records by identifier workflow”	Requirement
CRWF-4	A CR shall support the “Query patient demographic records by demographics workflow”	Requirement

3.2.2 OpenHIE CR Functional Requirements

The following are typical features of a client registry, or master patient index. Depending upon the desired use case(s), the system may support many or all of these functional features.

#	CR Functional Requirement	Recommendation/ Requirement
CRF-1	The system should support configurable entity matching, a service to assist in identifying duplicate patients. a. The rules for determining whether two records match each other should be configurable (e.g., ability to use both statistical and/or rules based, etc.). b. The blocking strategy for loading potential matches before the matching rules are applied should be configurable. c. Any configurable component should have an interface so that advanced users can write their own implementation from scratch if desired. d. Any interface should have at least one default implementation. e. The default implementation should be flexible and configurable so that non-programmers can adjust it to meet their needs. f. To the extent possible, CR system configuration information should be managed using consistent and easy to access methods, such as a database, properties files, or XML files). g. It should allow “wizard-based” or “guided” setup of matching rules.	Recommended
CRF-2	The system shall support patient linking and de-duplication. a. The system shall implement accurate and efficient patient linking and de-duplication methods. b. It shall provide an easy to use and intuitive way to see merge/linkage operations, c. It should allow an easy to use and intuitive way of manually accepting or rejecting merge suggestions, with	Required

	the ability to choose fields from either record to be merged.	
CRF-3	The system should support the ability to track and monitor inbound/outbound transactions. a. The system must have the capacity to record receipt and transmission of transactions.	Recommended
CRF-4	The system should support synchronization of client IDs with a Shared Health Record (SHR).	Recommended
CRF-5	The system should support a UI to review and manually adjudicate uncertain (“potential”) matches, and override incorrect matches.	Recommended
CRF-6	The system should support configurable attributes including: a. The attributes that form a patient record and are used for matching should be configurable. b. The implementation can include an example/default patient schema. c. It should be easy to add attributes to the schema. d. It should also be easy to remove attributes from the default model (or start over from scratch).	Recommended
CRF-7	The system should support error management a. Ensure that error handling comprehensively captures and logs all related exceptions, and to the extent possible, shows relationships between exceptions.	Recommended
CRF-8	The system shall manage a full audit log of changes to data as well as configurations as well as users.	Required
CRF-9	Privacy/Security: The system should have functions including user management and access controls.	Recommended
CRF-10	The system should be able to persist the parent/child relationship, birth order, and multi-birth indicator.	Recommended

3.3 OpenHIE Facility Registry (FR)

The purpose of a health facility registry is to act as the central authority to collect, store, and distribute an up to date and standardized set of facility data. The resulting standardized and current facility dataset stored in the registry is called the Master Facility List (MFL). While these concepts are closely related, a facility registry can be understood as the technology that manages and shares facility data and an MFL is the standardized data stored in the tool.

3.3.1 OpenHIE FR Workflow Requirements

#	FR Workflows (Described in detail in the later part of this document)	Recommendation/ Requirement
FRWF-1	Query health worker and/or facility records workflow.	Required

3.3.2 OpenHIE FR Functional Requirements

#	FR Functional Requirement	Recommendation/ Requirement
FRF-1	The system shall support the ability to create, define, and evolve the attributes & associated data dictionary for a registry.	Required
FRF-2	The system shall support the ability to create, define, and maintain multi-organizational hierarchies of facilities and related geo-objects.	Required
FRF-3	A system should support the collection of data for the following minimum facility attributes dataset: (Refer to WHO, USAID MFL resource package - Guidelines for countries) Signature Domain ● Facility name ● Facility type (e.g., hospital, clinic, mobile clinic, lab, pharmacy) ● Facility ownership/managing authority ● Facility physical address ● Facility contact information ● Record date	Recommended

	• Operational status • Administrative level/areas • Geographic coordinates • Facility unique identifier Service domain • Type of Services offered - Lab, HIV, TB, etc. • Human resource for health, numbers by cadre • Opening and closing times • Common and Mapped Identifiers per Location • Details on Infrastructure - Power, Water, etc.	
FRF-4	The system shall support the ability to set up and manage users, permissions for reading data, writing data (posting, validation, publishing), viewing data and system administration.	Required
FRF-5	At minimum an FR should support the ability to create roles and assign permissions to the roles. Example roles would be the Master Administrator, Data curator, Health Officer.	Recommended
FRF-6	The system should have flexible standards-based APIs, preferably RESTful API.	Recommended
FRF-7	The system should have the ability to pull and/or push data to other systems (.csv) based on defined criteria.	Recommended
FRF-8	The system shall support the ability to do bulk imports.	Required
FRF-9	The system should support the ability to search for facilities by attribute.	Recommended
FRF-10	The system should support the ability to see the facility located on a map.	Recommended
FRF-11	The system should allow public access to view data that is relevant to the public (e.g. services provided by a facility)	Recommended
FRF-12	The system should support facility data curation to manage site status changes (closures, openings, service changes)	Recommended
FR-13	The system should generate standard and customizable reports inline with the core FR attributes.	Recommended

FR-14	The facility registry should align with the primary Master Facility List at minimum, or influence its update.	Recommended

3.4 OpenHIE Health Worker Registry (HWR)

The Health Worker Registry serves as the central authority for maintaining the unique identities of health workers within a country. The Health Worker Registry is a database containing a minimum dataset of details of all health workers working in both the public and private sectors. With multiple and disparate sources of data on health workers, it is a complex task to pull together and maintain a master and canonical list of all health workers in a country. The health worker registry seeks to reduce the complexity of this task by:

- Pulling the minimum dataset of health workforce information from the various source data systems.
- Merging the source data systems into an authoritative registry of health workers according to a data governance policy.
- Allowing queries of health worker information by client systems.

3.4.1 OpenHIE HWR Workflow Requirements

A core principle of the OpenHIE architecture is to allow the various infrastructure services (such as the HWR) to be interchangeable. To support this, the OpenHIE Standards and Profiles used by the Health Worker Registry are outlined in the workflows below.

To be an OHIE HWR component, the HWR application must be able to support the OHIE workflows listed below. Implementations may support only the workflows needed to support their use case:

#	HWR Workflows (Described in detail in the later part of this document)	Recommendation/ Requirement
HWWF-1	Query health worker and/or facility records workflow.	Requirement (One of HWWF-1 or HWWF-2 must be supported)
HWWF-2	Query care services records workflow.	Requirement (One of HWWF-1 or HWWF-2 must be supported)
HWWF-3	Search care services workflow.	Recommendation
HWWF-4	Request care services updates workflow.	Requirement

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

3.4.2 OpenHIE HWR Functional Requirements

#	HWR Functional Requirement	Recommendation/ Requirement
HWRF-1	The system shall support the ability to query source data systems for updates to health worker data.	Required
HWRF-2	The system shall support the ability to retain received updates from source data systems.	Required
HWRF-3	The system shall support the ability to respond to queries on health worker data that has been stored.	Required
HWRF-4	The system should be able to send updates to upstream data repositories (such as an InterLinked Registry).	Recommended
HWRF-5	The system should support the ability to maintain old versions of health worker data when it has been updated.	Recommended
HWRF-6	The system should support the collection of data for the following minimum dataset: https://www.who.int/hrh/statistics/minimun_data_set/en/	Recommended
HWRF-7	The system should have flexible standards-based APIs, based on CSD or mCSD	Required

3.5 OpenHIE Terminology Service (TS)

The Terminology Services component of the OpenHIE Architecture provides a centralized source for the HIE's standards and definitions, including terminologies, ontologies, dictionaries, code systems, and value sets. Other HIE components can use these standards and definitions to normalize clinical data and achieve consistent aggregation and reporting.

By using Terminology Services, an HIE can achieve semantic interoperability of its data. Semantic interoperability (or interoperability of meaning) enables accurate, consistent reporting and aggregation of clinical data. It also enables accurate exchange of information among members of the provider community, including labs, clinics, pharmacies, hospitals and imaging centers, which leads to improved patient care decisions.

Benefits of the use of a Terminology Service include:

- **Standard Data:** Using common terminology is vital for knowledge sharing over multiple locations. National and international code systems and value sets should be readily available for validation, comparison, and aggregation with local data.
- **Improved Care:** Accurate and consistent data collection improves patient care analysis. Comparable patient data within and between patient populations leads to more consistent care delivery.
- **Better Reporting:** Standardized data element representations result in consistent and accurate reporting.
- **Coordinated Care:** Consistent and comparable analysis of healthcare utilization data leads to more informed decisions about resource allocation.

3.5.1 OpenHIE TS Workflow Requirements

A Terminology Service exposes a set of run-time functions (services) that support other OHIE components. These Terminology Service functions are typically actions found in the primary OHIE Workflows (see example below). Four primary functions have been identified. Depending upon the specific Workflows required in an implementation, not all of these functions may be required, but an OHIE-compliant Terminology Service should support all of these features.

To be an OHIE TS component, the TS application must be able to support the OHIE workflows listed below. Implementations may support only the workflows needed to support their use case. All of the required functions below are to be implemented using the associated HL7 FHIR Terminology Service specifications, e.g. Resources and Operations. These workflows also conform to the IHE Infrastructure Technical Framework Supplement - Sharing Value Sets, Codes, and Maps (SVCM) specification.

#	TS Workflows (Described in detail in the later part of this document)	Recommendation/ Requirement
TSWF-1	Verify Code Existence	Requirement
TSWF-2	Verify Code Membership	Requirement
TSWF-3	Expand Value Set	Requirement
TSWF-4	Query Concept Map	Requirement
TSWF-5	Query Code System	Requirement
TSWF-6	Query Value Set	Requirement
TSWF-7	Lookup Code	Requirement

TSWF-8	Translate Code	Requirement

3.5.2 OpenHIE TS Functional Requirements

#	TS Functional Requirements	Recommendation / Requirement
TSF-1	The TS shall support import of local (e.g., local lab codes) and standard code systems (e.g., LOINC).	Requirement
TSF-2	The TS shall allow for export of local (e.g. local lab codes) and standard code systems (e.g., LOINC).	Requirement
TSF-3	The TS should support versioning of code systems - storing and making multiple versions of a code system available via terminology services.	Recommendation
TSF-4	The TS should support versioning of value sets - storing and making multiple versions of a value set available via terminology services.	Recommendation
TSF-5	The TS shall allow support import of value set definitions. The import format may vary from a text file containing a list of codes to an FHIR Value Set resource in XML or JSON format.	Requirement
TSF-6	The TS shall allow for export of value sets definitions. The export format may vary from a text file containing a list of codes to an FHIR Value Set resource in XML or JSON format.	Requirement
TSF-7	The TS shall allow for the import of value set expansions. The import format may vary from a text file containing a list of codes to an FHIR Value Set resource in XML or JSON format.	Requirement
TSF-8	The TS shall allow for export of value sets expansions. The export format may vary from a text file containing a list of codes to an FHIR Value Set resource in XML or JSON format.	Requirement
TSF-9	Allow for the import of relationships between codes (i.e., concept maps). The import format may vary from a text file containing source and target codes to an FHIR Concept Map resource in XML or JSON format.	Requirement

TS -10	Allow for the export of relationships between codes (i.e., concept maps). The export format may vary from a text file containing source and target codes to an FHIR Concept Map resource in XML or JSON format.	Requirement
TSF-11	Expose services that allow for the retrieval of a code, and additional information about the code such as definition and status, from a particular code system (and code system version if provided).	Requirement
TSF-12	Expose services that allow for the validation of a code (i.e., does the code exist) against a particular code system (and code system version if provided).	Requirement
TSF-13	Expose services that utilize concept maps to retrieve a target code given a source code within the concept map.	Requirement

3.6 OpenHIE Shared Health Record (SHR)

The Shared Health Record (SHR) facilitates the sharing of clinical information between health information systems to enable better patient care, thus improving health outcomes. The Shared Health Record is a means of allowing different services to share health data stored in a centralized data repository. It contains a subset of normalized data for a patient from various systems such as an electronic medical record or the Laboratory Information Management System. This record is queried and updated between the different institutions and systems that are authorized to do so. The Shared Health Record is distinct from a data warehouse; it is an operational, real-time transactional data source.

A shared health record is normalised if all metadata items such as patient, provider, and facility identifiers are resolved to appropriate universal identifiers (as opposed to their local identifiers as used by a client system). In addition, all terminology codes in use need to be mapped to an appropriate reference terminology to ensure that the information is consistently understood.

3.6.1 OpenHIE SHR Workflow Requirements

A core principle of the OpenHIE architecture is to allow the various infrastructure services (such as the SHR) to be interchangeable. To support this, the OpenHIE Standards and Profiles used by the Shared Health Record are outlined in the workflows below.

To be an OHIE SHR component, the SHR application must be able to support the OHIE workflows listed below. Implementations may support only the workflows needed to support their use case:

#	SHR Workflows (Described in detail in the later part of this document)	Recommendation/ Requirement

SHRWF-1	Save patient-level clinical data workflow	Requirement
SHRWF-2	Query patient-level clinical data workflow	Requirement

3.6.2 OpenHIE SHR Functional Requirements

#	SHR Functional Requirement	Recommendation/ Requirement
SHRF-1	Stores patient level clinical data that forms a patient's electronic health record a. Stores unstructured clinical data such as PDFs and narrative text b. Stores structured clinical data such as an encounter with several discrete observations, compatible with a standard exchange format c. Relating clinical information to other clinical information, e.g., annotating/describing a document with discrete observations	Recommended
SHRF-2	Expose services that have the ability to receive and save patient clinical data in unstructured form, both text or binary (PDF/image), annotated with sufficient metadata to identify patient/provider.	Recommended
SHRF-3	Expose services that have the ability to receive and save patient clinical data in a structured form such as CDA documents or FHIR resources.	Recommended
SHRF-4	Expose services that have the ability to receive and save patient clinical data In a form that contains both structured and unstructured elements.	Recommended
SHRF-5	Exposes services that respond to queries for a patient's EHR a. Can return a specific known document or a list of documents for a patient (as it was submitted) b. Can return a list of discrete observations for a patient	Recommended

	that satisfy specific query parameters. This data can subsequently be used for trending or providing the previous encounters that a patient has had. c. Can return a full set of clinical information stored about a patient d. Return patient summary - everything the SHR knows about a patient with links to fetch the individual data items	
SHRF-6	The SHR shall maintain the context in which the data was submitted.	Recommended
SHRF-7	The SHR should keep detailed audit logs of all interactions with clinical data a. Keep audit logs of any clinical and demographic data that is stored or changed. Logging who has accessed/viewed clinical information does NOT need to be stored, this is something that an interoperability layer could log. b. Records and versions updates; records can never be deleted, only marked as such; any previous update should not rewrite old data; no information should ever be removed from the system.	Recommended
SHRF-8	The SHR should support the ability to export data for secondary use.	Recommended
SHRF-9	The SHR should provides interfaces/extension points at various stages of the data lifecycle to allow for semantic validation or simple decision support.	Recommended
SHRF-10	The SHR should allow for storage and retrieval of basic privacy/policy constraints (access control-restrict part of record and restrict entire record).	Recommended
SHRF-11	The SHR should be able to store identified and predefined observational data mapped to standard reference terminology.	Recommended
SHRF-12	The SHR should have a mechanism to resolve conflicts if records are submitted simultaneously.	Recommended

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

3.7 OpenHIE Health Management Information System (HMIS)

A Health Management Information System (HMIS), also called a Routine Health Information System, facilitates the collection of periodic health service delivery and public health indicators from a variety of information systems and the effective use of information at facility, district, and higher levels to help improve health care outcomes.

3.7.1 OpenHIE HMIS Workflow Requirements

The following workflow is currently supported, and an FHIR-based message is emerging.

#	HMIS Workflows (Described in detail in the later part of this document)	Recommendation / Requirement
HMISWF-1	Validate and Save Aggregate Data	Required

3.7.2 OpenHIE HMIS Functional Requirements

#	HMIS Functional Requirements	Recommendation / Requirement
HMISF-1	An HMIS shall act as a datastore for integrated health system data which can be used for better decision making in the health system.	Required
HMISF-2	An HMIS should provide mechanisms (preferably web based) for data entry.	Recommended
HMISF-3	An HMIS should provide mechanisms to improve the quality and validity of data (smart forms, validation rules, etc.).	Recommended
HMISF-4	An HMIS should provide standard interfaces for the importing of data from other systems (e.g., ADX, FHIR).	Recommended
HMISF-5	An HMIS should support the use of an accurate list of health facilities and their geographic and administrative distribution.	Recommended
HMISF-6	An HMIS should provide interfaces for sharing health facility information with other systems (facility registry).	Recommended

HMISF-7	To support its primary function of data use, an HMIS should: • Be able to further aggregate and analyze data (e.g., provide annual report from monthly data) • An HMIS should offer an interface to query its data in a flexible way across different dimensions (analytics API) • An HMIS should provide customized graphic visualizations of data	Recommended

3.8 OpenHIE Finance and Insurance Service

Finance and Insurance Service stores, categorizes, and facilitates the administration of centralised claims and finance related data to care provision to patients within the HIE. The service receives claims/financial data from Point of Service applications (including financing applications acting as a point of service interface outside of other PoS systems) and curates the management of them.

3.9 OpenHIE Product Catalogue (PC)

A Product Catalogue serves as the source of truth about what a Product is within an HIE. It sources the information for this role through two expected means: 1) as the ongoing result of a process of master data management to properly define and categorize medical products and 2) as derived data on the proper definition and categorization of medical products (e.g., GS1 GDSN).

3.9.1 OpenHIE PR Workflow Requirements

The product catalogue workflow requirements are yet to be determined.

3.9.2 OpenHIE PR Functional Requirements

The product catalogue functional requirements are yet to be determined.

3.10 OpenHIE Logistics Management Information System (LMIS)

A Logistics Management Information System (LMIS) is an IT system that plays a central role in enabling commodity visibility and operational management of a wide-area supply chain operations. Typically the commodities in this supply chain are health-related, with the organization that sponsors the system a department or agency under a government's health ministry, and the operation is carried out at scale for an entire region or even an entire nation. An LMIS typically bridges the health and supply chain operations by enabling re-supply workflows for clinical locations and the vertical programs targeting families of commodities, as well as interfacing with supplier's IT systems to ensure the re-supply process is fulfilled as needed. Particular LMIS tools may have additional capabilities that enhance these re-supply workflows and/or add to the maturity of the wider supply chain operations.

3.10.1 OpenHIE LMIS Workflow Requirements

The LMIS workflow requirements are yet to be determined.

3.10.2 OpenHIE LMIS Functional Requirements

The LMIS functional requirements are yet to be determined.

3.11 OpenHIE Interoperability Layer (IOL)

While the roles of other OHIE components that provide services may be more easily understood, it is the IOL that secures and orchestrates the exchange of information. Similar to an orchestra conductor, the IOL provides the central force that enables all of the HIE components to work together and interact with Point-of-Service systems outside the HIE.

3.11.1 OpenHIE IOL Workflow Requirements

To be OHIE IOL component, the IOL application must be able to support the following required standard:

#	IHE Standard	Recommendation / Requirement
IOLWF-1	IHE ATNA - this is split into two logical parts ● AT (Audit Trail) - Which describes how audit messages can be sent and stored in a central repository which in this case would be the IOL ● NA (Node Authentication) - Which describes how the IOL can authenticate clients (external systems) that want to send request into the exchange	Required

In addition to this, the Interoperability layer is architected to be the single point of entry into an HIE. This means that the IOL should be involved in **every OpenHIE workflow**. It transparently handles transaction routing, security and auditing as these are common functions that are necessary in all workflows.

3.11.2 OpenHIE IOL Functional Requirements

#	IOL Functional Requirements	Recommendation/ Requirement
IOLF-1	The system should provide a central point of access for the services of the HIE. For example, this interface will provide access to the CR, PR, FR and SHR. This central point of access simplifies security management and provides a single entry point into the HIE.	Recommended

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

IOLF-2	The system shall provide routing functions that allow messages to be routed to the correct service provider systems within the HIE.	Requirement
IOLF-3	The system shall provide a central logging mechanism for the messages sent through the exchange. This function should log copies of the messages that travel through the interoperability layer for audit and reporting purposes.	Requirement
IOLF-4	The system should allow for the rerunning of failed transactions at a central level, alleviating the need for Point-of-Service systems to resend data, for example, in the event of a problem with an infrastructure component.	Recommended
IOLF-5	Should support transformation of messages that travel from the interoperability layer to service provider systems and vice versa if the service provider is not able to communicate in the required format, i.e. provides implementation specific adapters to transform messages from the interoperability layer's internal form to a form that the service provider expects (e.g., SHR, CR, PR).	Recommended
IOLF-6	The system should allow for the routing of messages to the appropriate architecture component or external Point-of-Service system. ● Performs orchestration tasks for complex transactions to take the burden off client systems. This orchestration may contact multiple service providers within the HIE on a client's behalf and compile an appropriate response to return to the client. ● Examples of orchestration could be the execution of a care plan or the validation of elements (such as identifiers or codes) in a message against other service providers within the HIE (e.g., PR, CR, FR, TS). ● Orchestration tasks are those that are required to complete the current transaction and therefore must be executed timeously as the transaction cannot continue without these steps.	Recommended
IOLF-7	The systems shall include an interface into which a workflow engine can be connected. ● This workflow engine should be able to keep track of the long running state of a patient's care and would be able	Requirement

	to perform actions based on this context (such as sending alerts) to improve patient care. • This workflow engine is out of scope for an Interoperability Layer. However, the Interoperability Layer is expected to expose an interface to allow this sort of systems to be implemented.	
IOLF-8	The system should support the ability to be extended by allowing additional mediation functions to be added or removed as they are needed.	Recommendation
IOLF-9	The system shall support a mechanism for error management and tracking, e.g. a console for viewing failed transactions.	Requirement
IOLF-10	The system shall allow for failed transactions to be grouped by error type and reason so that errors can be rectified efficiently by finding the root cause of the error, fixing the problem, and re-running those transactions.	Requirement
IOLF-11	The system should support the ability for a user to re-run errored transactions through the HIE once the reason for their failure has been rectified.	Recommendation
IOLF-12	The system shall provide authorized users with a view of metrics for monitoring the flow of messages through the HIE.	Requirement
IOLF-13	The system shall manage the security of the HIE through authentication (identity verification), authorization (permission to interact with specified HIE components) and encryption and decryption of messages.	Requirement
IOLF-14	The system shall support Authentication and Authorization of systems trying to send data to the HIE.	Requirement
IOLF-15	The system should support the encryption of data in flight (when not on a physically secure network) and at rest (whenever data is stored, e.g. when transactions are stored for logging).	Recommendation
IOLF-16	The system should capture monitoring statistics, such as transaction loads and performance metrics, and provides a view of these for monitoring the flow of messages through the HIE.	Recommendation

4. OpenHIE Workflow (Exchange) Specifications

4.1 Introduction

OpenHIE workflows are the technical **data exchange patterns** for sharing health data between one or more of the OpenHIE Architecture components and/or other health information systems. As specified in the process documented above, the OpenHIE workflows have been vetted and agreed upon by the OpenHIE Architecture Review Board. The purpose of this section is to document the workflow specifications for OpenHIE. New workflows are being created and additional standards such as FHIR may not yet be incorporated and this type of work in progress may be found on the OpenHIE wiki. In addition, you are invited to join our processes and contribute new workflows for the next release.

For each workflow the following is documented:

- Maturity - Each workflow's maturity is subjectively documented based upon the following factors:
    - The workflow is defined and ARB approved
    - The workflow is supported by standards
    - The maturity of the underlying standards or profiles
    - The number of implementations
- Standards - IHE profiles that are the building blocks for the OpenHIE workflows. These IHE Profiles represent the conformance-testable descriptions of how actors in an interoperable data exchange must behave. The maturity of the underlying FHIR standards, themselves, is identified on the front page of the IHE Profile specification itself. FHIR *resource* list can be displayed and sorted by maturity; this list is found, here: https://www.hl7.org/fhir/resourcelist.html. (The FHIR maturity levels are defined, here: https://www.hl7.org/fhir/versions.html#maturity).
- Assumptions and Prerequisites - Conditions that are expected to be in place to support the workflow.
- Actors - The systems or HIE components that have roles in the data exchange process being specified.
- Interaction diagram - The visual description of how the data moves between systems.
- Interaction diagram steps - Details explaining the steps in the interaction diagram.

4.2 Aggregate Reporting Workflows

This collection of workflows is designed to support aggregate data exchange of health indicators. To fully support this capability, metadata describing the indicators also needs to be translated or exchanged.

The workflows in this collection are designed to support the following types of data exchanges:

1. Sending an aggregate data message from an HIE or another application.
2. An HIE receiving an aggregate data message.

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

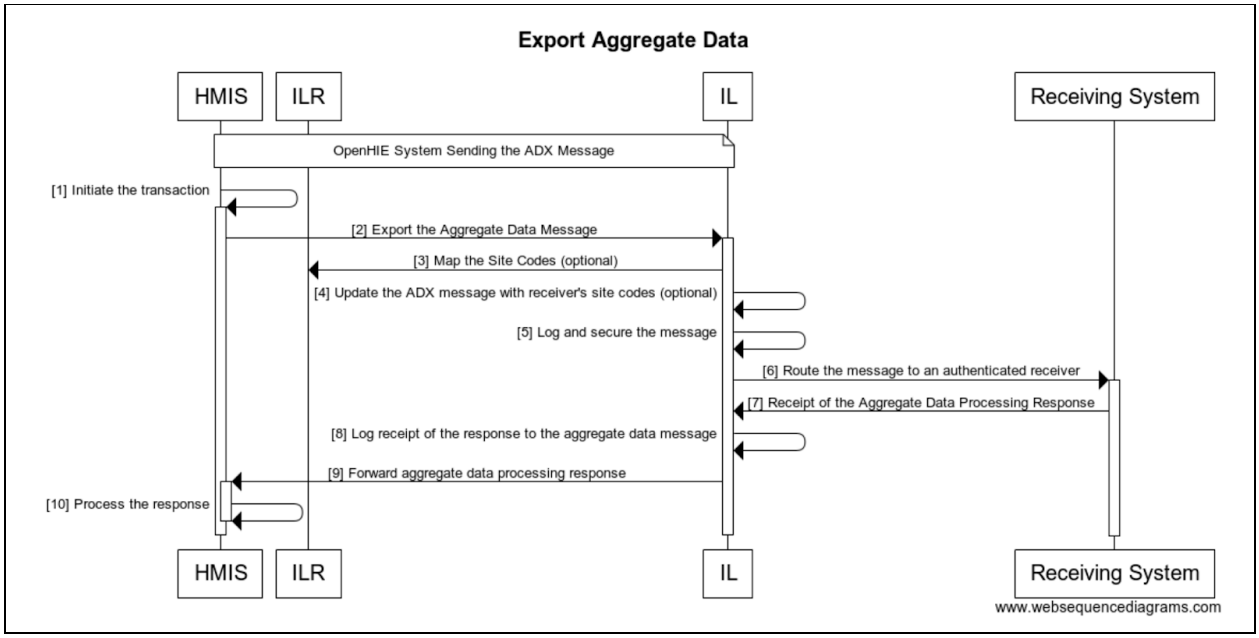
4.2.1 Export Aggregate Data

This workflow enables aggregate data to be generated and exported to another system. This is useful for exporting routine reporting data to an upstream HMIS system for high-level reporting.

Workflow Maturity	 Maturing	• Workflow is defined and ARB approved • Workflow is supported by the IHE ADX profile
Standards*	ADX for structuring aggregate data - http://www.ihe.net/uploadedFiles/Documents/QRPH/IHE_QRPH_Suppl_ADX_Rev1.0_PC_2015-05-29.pdf	
Assumptions and Prerequisites	The External HMIS and the HMIS inside the OpenHIE infrastructure must use the same metadata (indicators, disaggregates and facilities) or there must be translation steps added.	
Actors	Receiver • HMIS- The system that will be **receiving** aggregate data. Examples of this system could be an external HMIS system or an HIE. Sender • IOL - The Interoperability Layer (IOL) is the component that enables easier interoperability between disparate information systems by connecting the infrastructure services and client applications together. An interoperability layer receives transactions from the point of service systems and coordinates interaction between components of the HIE and provides common core functions to simplify the interoperability between systems. • HMIS - The system that **produces** the aggregate data to be exported.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.2.1.1 Interaction Description



#	Interaction	Data / Note	Transaction Standards
1	Initiate the transaction, aggregate months into quarters as necessary and create the aggregate data message.	ADX - Aggregate Data generated by the HMIS.	ADX
2	Export the Aggregate Data Message to the IL	ADX - Aggregate Data generated by the HMIS.	ADX
3	Map site codes (optional if site / facility codes are	Mapping Mediator uses a CSD transaction to determine if there are local site codes that need to be	CSD

	aligned between the two systems)	translated to the Global site codes. If so, they are translated.	
4	Update the ADX message with the receiver's site codes	Update the ADX message with receiver's site codes.	
5	Return processing response	The External system will process the aggregate data message and respond with information about the records processed and/or provide a description of errors. May contain error messages and/or confirmation of successful processing.	
6	Log the processing response		
7	Forward aggregate data processing response		
8	Process the response	This step can be different for different implementations. The HMIS can be used to inform the user via an interface or a message. The response will contain error messages or provide information about the successful processing of the message.	

4.2.2 Validate and Save Aggregate Data

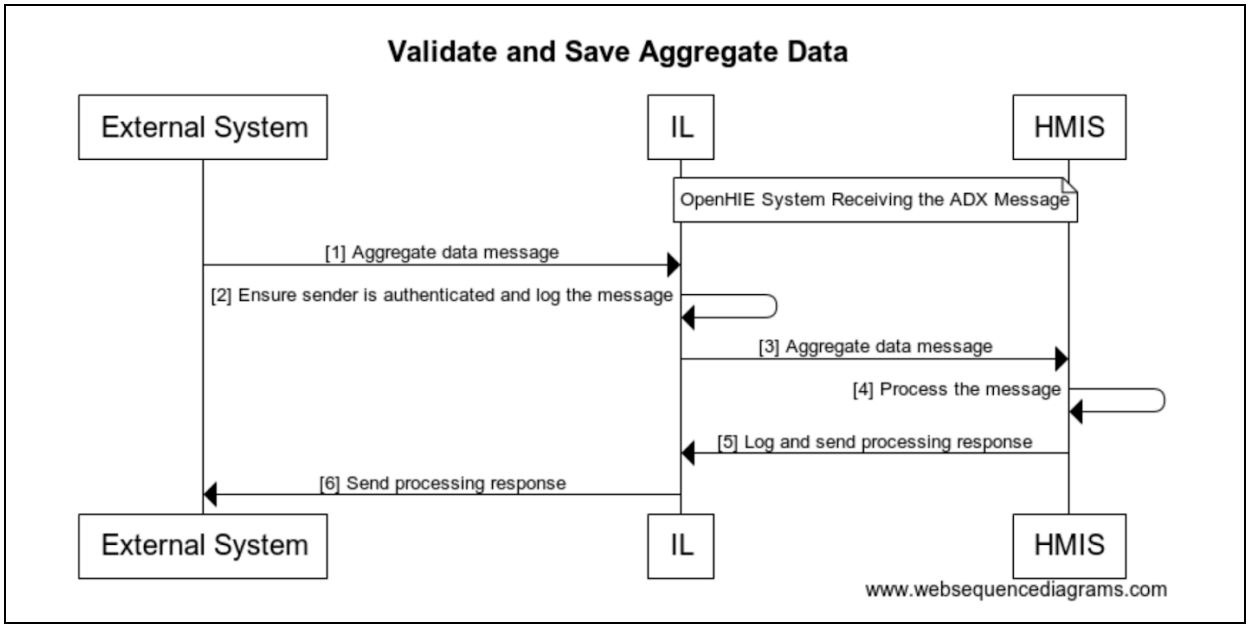
This workflow specifies the interactions for validating and saving an aggregate data message that has been transmitted from an external system to the HIE.

Workflow Maturity	 Maturing	• Workflow is defined and ARB approved • Workflow is supported by emerging IHE ADX standard

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

Standards*	ADX for structuring aggregate data - http://www.ihe.net/uploadedFiles/Documents/QRPH/IHE_QRPH_Suppl_ADX.pdf
Assumptions and Prerequisites	The sender and receiver have the same metadata (indicator, disaggregators and facilities). If not, the metadata will need to be translated.
Actors	Sender - External System Actor • The system **sending** the ADX message. The system may be a Health Information Exchange with patient-level abilities to aggregate data and/or a system that contains aggregate level data. The system may also be a point-of-service system that contains or produces aggregate data. Receiving HIE • IL -The Interoperability Layer (IL) is the component that enables easier interoperability between disparate information systems by connecting the infrastructure services and client applications together. An interoperability layer receives transactions from the external system and coordinates interaction between components of the HIE and provides common core functions to simplify the interoperability between systems. • HMIS - Health Management Information System that is processing and storing the aggregate data (ADX message) **received**.

4.2.2.1 Interaction Description



For information about IHE Standard Maturity, see the standard (see section 4.1)

#	Interaction	Data / Notes	Transaction Options
1	Receive Aggregate Data Message (The process is initiated by the receipt of an Aggregate Data Message.)	ADX data	ADX - http://www.ihe.net/uploadedFiles/Documents/QRPH/IHE_QRPH_Suppl_ADX.pdf
2	Ensure sender is authenticated and log a copy of the message		
3	Route message to the HMIS	Implementation choice: Implementers may select to validate the aggregate data message with a DSD before routing it to the HMIS.	
4	Process the ADX Message	Implementation requirements: Each implementation may have specified rules or data checks that are performed on the message as it is imported into the system. These checks may include data/metadata checks, numerator and denominator checks and checks to be sure that reporting entities reported on the desired indicators.	
5	(Optional) Generate processing response	The current ADX standard does not specify a processing response.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

6	(Optional) Log the processing response and return it to the ADX		

4.3 Alerting / Sending Reminders or Information

These workflows are designed to facilitate one-way communication to a client or provider listed in the HIE. The workflows are designed to support use cases such as care reminders or crisis communications

1. Sending alerts to patients or those for whom care or services are being provided.
2. Sending alerts to providers or those who are providing care.

4.3.1 Send Client Alert Workflow

The send alert workflow allows the infrastructure services to register alerts with an alert service. The alert service allows alert consumers to query for these alerts and send them out to clients (patients) in whatever format is appropriate (SMS, email, etc).

An alert is intended as a largely one way communication to a client of the system. Use cases for alerts include:

1. **Crisis Response**
   In response to a crisis or emergency situation, such as the 2014 and 2015 outbreaks of Ebola in western Africa, it is critical to communicate to clients within a particular health care network and to verify, to the extent possible, the receipt of the alert.
2. **Care Reminders**
   A subject of care may receive care from multiple providers across multiple health care networks, and coordination of care across providers and networks is difficult. If an Electronic Medical Record or Longitudinal/Shared Health Record is present, Care Reminder alerts can be triggered through the examination of clinical records about the subject of care. Care Reminder alerts are sent either to the subject of care.

Though the infrastructure of the alerting workflow indicated below would permit communication of many types of additional messages, alerts, or notifications, it is not intended that these messages exceed the above use cases. In particular, these do not include "Critical Findings" or other types of alerts which require immediate action.

The IHE mACM standard on which this workflow expects that additional IHE profiles utilizing mACM would be developed to address broader alerting workflows.

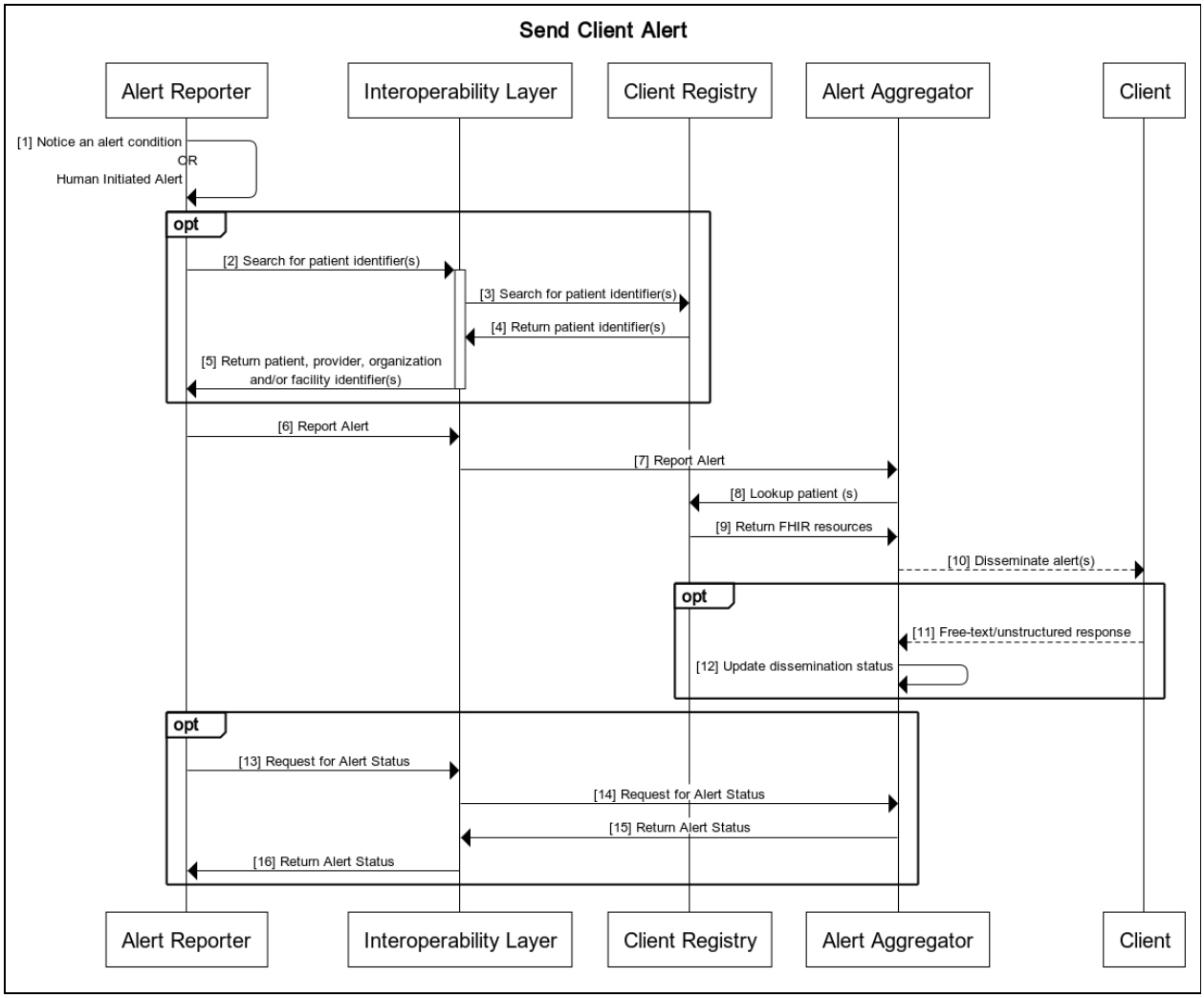
Workflow Maturity	 Maturing	• Workflow is defined and ARB Approved • Workflow is supported by emerging IHE mACM standard in Trial Implementation
Standards*	1. FHIR DSTU2 search on Location, Provider or Patient resources / FHIR DSTU2 bundle search response **OR** ITI-73 Find Matching Services CSD Request / ITI-73 Find Matching Services response 2. FHIR search on Patient resources (PDQm) request / FHIR DSTU2 bundle search response **OR** PIX/PDQ request / PIX/PDQ response	
Assumptions and Prerequisites	None	
Actors	**Alert Reporter** - The point-of-service system that captures patient identifiers, is responsible for sending the identifiers to the HIE. An Alert Reporter shall originate or relay alerts (an alarm, either physiological or technical, or an advisory) to the Alert Aggregator. This actor can optionally query an Alert Aggregator Actor for statistics related to the dissemination of this alert to the intended recipient(s) In the workflow below, the Alert Report is presented as a generic actor. Examples include: • A Health Management Information System (HMIS) notices that a threshold indicator on the number of cases of cholera for a district. An HMIS could act as an Alert Reporter by querying a health worker registry to determine a list of all clients in the district and generate an alert indicating that they should be advised of the increased number of cholera cases and provide information about disease prevention. • A mediator in the Interoperability Layer could monitor a Shared Health Record and notice that a child has missed a vaccination according to an established protocol of care. The Mediator would act as an Alert Reporter and issues an SMS reminder to send to the mother or other designated guardian. • A Mediator can monitor a central Electronic Referral System and a Shared Health Record to detect if the patient has missed their referral by checking if an encounter has been received at the Longitudinal Health Record within the time frame indicated in the referral. If an encounter has	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

not been received the Mediator acts as an Alert Reporter and sends out an out an alert of the missed appointment to the client.

Alert Aggregator - A system responsible for distributing an alert to a client. The alert aggregator manage these alerts according to the required jurisdiction defined business context, for example dispatching them onto a communications platform for delivery to an intended recipient.
The Alert Aggregator may optionally collect statistics related to the dissemination of the alert such as delivery status or the value of an SMS response or acknowledgment.

4.3.1.1 Interaction Description



#	Interaction	Data / Notes	Transaction Options
1	Notice an alert condition (Defined by business rules of Alert Reporter)		
2	Search for patient identifier(s)		FHIR search on Patient resources (PDQm) request OR PIX/PDQ request
3	Search for patient identifier(s)		
4, 5	Return identifiers	FHIR transactions are more aligned with the mACM ITI-84 transaction which has references to Organization, Location (e.g., facility) or Provider resources	FHIR DSTU2 bundle search response OR PIX/PDQ response
6	Report Alert	Identifiers of recipients passed either by reference to appropriate FHIR resource (requires FHIR server for those resources) OR Identifiers of recipients passed as embedded reference to appropriate FHIR resources (does not require FHIR server)	Mobile Report Alert ITI-84 (mACM)
7	Report Alert		Mobile Report Alert ITI-84 (mACM)

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

8	Search for patient identifier(s)		FHIR search on Patient resources (PDQm) request OR PIX/PDQ request
9	Return identifiers	Current reference implementation of ILR (OpenInfoMan) supports both of these transactions. FHIR transactions are more aligned with the mACM ITI-84 transaction which has references to Organization, Location (e.g., facility) or Provider resources	FHIR DSTU2 bundle search response OR PIX/PDQ response
10	Disseminate Alert		Disseminate alert(s) via appropriate communication mechanisms available to the HIE (SMS, email, POC system, etc). Transactions depend on the communication channel.
11	Response		
12	Update dissemination status		Transactions are not specified (currently) by mACM standard. Note: RapidPro uses custom FHIR compliant endpoint "Communication/$response" and "Communication/$sent" for this.
13	Request for Alert Status		Query for Alert Status ITI-85 (mACM) Request
14	Request for Alert Status		Query for Alert Status ITI-85 (mACM) Request

15	Return Alert Status		Query for Alert Status ITI-85 (mACM) Response
16	Return Alert Status		Query for Alert Status ITI-85 (mACM) Response

4.3.2 Send Health Worker Alert Workflow

The send alert workflow allows the infrastructure services to register alerts with an alert service. The alert service allows alert consumers to query for these alerts and send them out to health workers in whatever format is appropriate (SMS, email, etc).

An alert is intended as a largely one way communication to a health worker. Use cases for alerts include:

1. **Crisis Response**
   In response to a crisis or emergency situation, such as the 2014 and 2015 outbreaks of Ebola in western Africa, it is critical to communicate to health workers within a particular health care network and to verify, to the extent possible, the receipt of such an alert.
2. **Care Reminders**
   A subject of care may receive care from multiple providers across multiple health care networks, and coordination of care across providers and networks is difficult. If an Electronic Medical Record or Longitudinal/Shared Health Record is present, Care Reminder alerts can be triggered through the examination of clinical records about the subject of care. Care Reminder alerts are sent either to the subject of care or a designated health worker.

Though the infrastructure of the alerting workflow indicated below would permit communication of many types of additional messages, alerts, or notifications, it is not intended that these messages exceed the above use cases. In particular, these do not include "Critical Findings" or other types of alerts which require immediate action by a health worker.

The IHE mACM standard on which this workflow expects that additional IHE profiles utilizing mACM would be developed to address broader alerting workflows.

Workflow Maturity	 Maturing	• Workflow is defined and ARB Approved • Workflow is supported by emerging IHE mACM standard in Trial Implementation
Standards*	1. FHIR DSTU2 search on Location, Provider or Patient resources / FHIR DSTU2 bundle search response **OR**	

For information about IHE Standard Maturity, see the standard (see section 4.1)

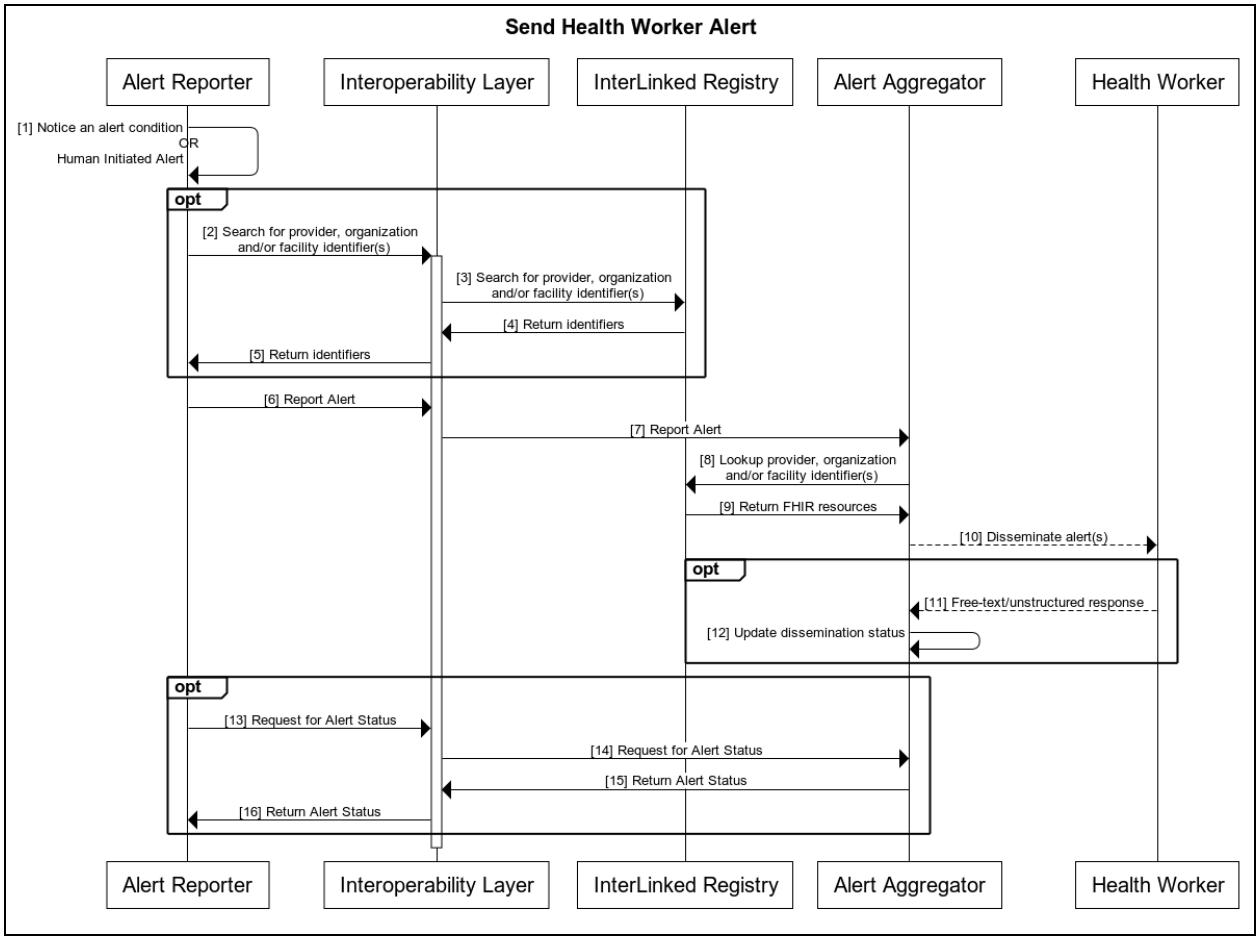
	ITI-73 Find Matching Services CSD Request / ITI-73 Find Matching Services response 2. FHIR search on Patient resources (PDQm) request / FHIR DSTU2 bundle search response **OR** PIX/PDQ request / PIX/PDQ response
Assumptions and Prerequisites	None
Actors	**Alert Reporter** - The point-of-service system that captures patient identifiers, is responsible for sending the identifiers to the HIE. An Alert Reporter shall originate or relay alerts (an alarm, either physiological or technical, or an advisory) to the Alert Aggregator. This actor can optionally query an Alert Aggregator Actor for statistics related to the dissemination of this alert to the intended recipient(s) Examples include: ● A Health Management Information System (HMIS) notices that a threshold indicator on the number of cases of cholera for a district. An HMIS could act as an Alert Reporter by querying a health worker registry to determine a list of all Nurses in a district and generate an alert indicating that they should be advised of the increased number of cholera cases. ● A Ministry of Health employee wishes to notify health workers of a delay in payment. The employee interacting with a Human Resource Information System (HRIS) could act as an Alert Reporter by initiating an alert to all formal sector paid employees to indicate that there will be a delay. ● A Mediator in the Interoperability Layer could monitor a Shared Health Record and notice that a child has missed a vaccination according to an established protocol of care. The Mediator would act as an Alert Reporter and issue an SMS reminder to send to the mother or other designated guardian. In the case when a mother does not have access to a cell-phone or other electronic device, an alert should be generated and sent to the child's caregiver. This caregiver could be a Community Health Worker, a village elder, or a sub-village chairman. ● A Mediator can monitor a central Electronic Referral System and a Shared Health Record to detect if the patient has missed their referral by checking if an encounter has been received at the Longitudinal Health Record within the time frame indicated in the referral. If an encounter has not been received the Mediator acts as an Alert Reporter and sends out

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

an alert of the missed appointment to inform the health worker that originally interfaced with that client.

Alert Aggregator - A system responsible for distributing an alert to a health worker. The alert aggregator manages these alerts according to the required jurisdiction defined business context, for example dispatching them onto a communications platform for delivery to an intended recipient.
The Alert Aggregator may optionally collect statistics related to the dissemination of the alert such as delivery status or the value of an SMS response or acknowledgment.

4.3.2.1 Interaction Description



#	Interaction	Data / Notes	Transaction Options
1	Notice an alert condition (Defined by business rules of Alert Reporter)		
2	Search for provider, organization and/or facility identifier(s)	Alert Report constructs query according to business rules under which alert was initiated. FHIR transactions are more aligned with the mACM ITI-84 transaction which has references to Organization, Location (e.g., facility), or Provider resources.	FHIR DSTU2 search on Location, Provider or Patient resources OR ITI-73 Find Matching Services CSD Request
3	Search for provider, organization and/or facility identifier(s)		FHIR DSTU2 search on Location, Provider or Patient resources OR ITI-73 Find Matching Services CSD Request
4, 5	Return identifiers	FHIR transactions are more aligned with the mACM ITI-84 transaction which has references to Organization, Location (e.g., facility) or Provider resources	FHIR DSTU2 bundle search response OR ITI-73 Find Matching Services response
6	Report Alert	Identifiers of recipients passed either by reference to appropriate FHIR resource (requires FHIR server for those resources) OR Identifiers of recipients passed as embedded reference to appropriate FHIR resources (does not require FHIR server)	Mobile Report Alert ITI-84 (mACM)

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

7, 8, 9	Report Alert	Mobile Report Alert ITI-84 (mACM)	Mobile Report Alert ITI-84 (mACM)
10	Disseminate Alert	Disseminate alert(s) via appropriate communication mechanisms available to the HIE (SMS, email, POC system, etc). Transactions depend on the communication channel.	
11, 12	Update dissemination status	Transactions are not specified (currently) by mACM standard. Note: RapidPro uses custom FHIR compliant endpoint "Communication/$response" and "Communication/$sent" for this. We can submit a Change Proposal to standardize this	
13	Request for Alert Status		Query for Alert Status ITI-85 (mACM) Request
14	Request for Alert Status		Query for Alert Status ITI-85 (mACM) Request
15	Return Alert Status		Query for Alert Status ITI-85 (mACM) Response
16	Return Alert Status		Query for Alert Status ITI-85 (mACM) Response

4.4 Care Services Discovery

This collection is designed to allow external systems such as point-of-care systems to query for provider, facility, organization and/or healthcare service information.

The workflows in this collection are designed to support the following types of data exchanges:

1. Query for practitioner information.
2. Query for facility information.
3. Query for organization information.
4. Query for healthcare service information.
5. Query for any of the above information that is linked together.

4.4.1 Query Health Worker and/or Facility Records Workflow

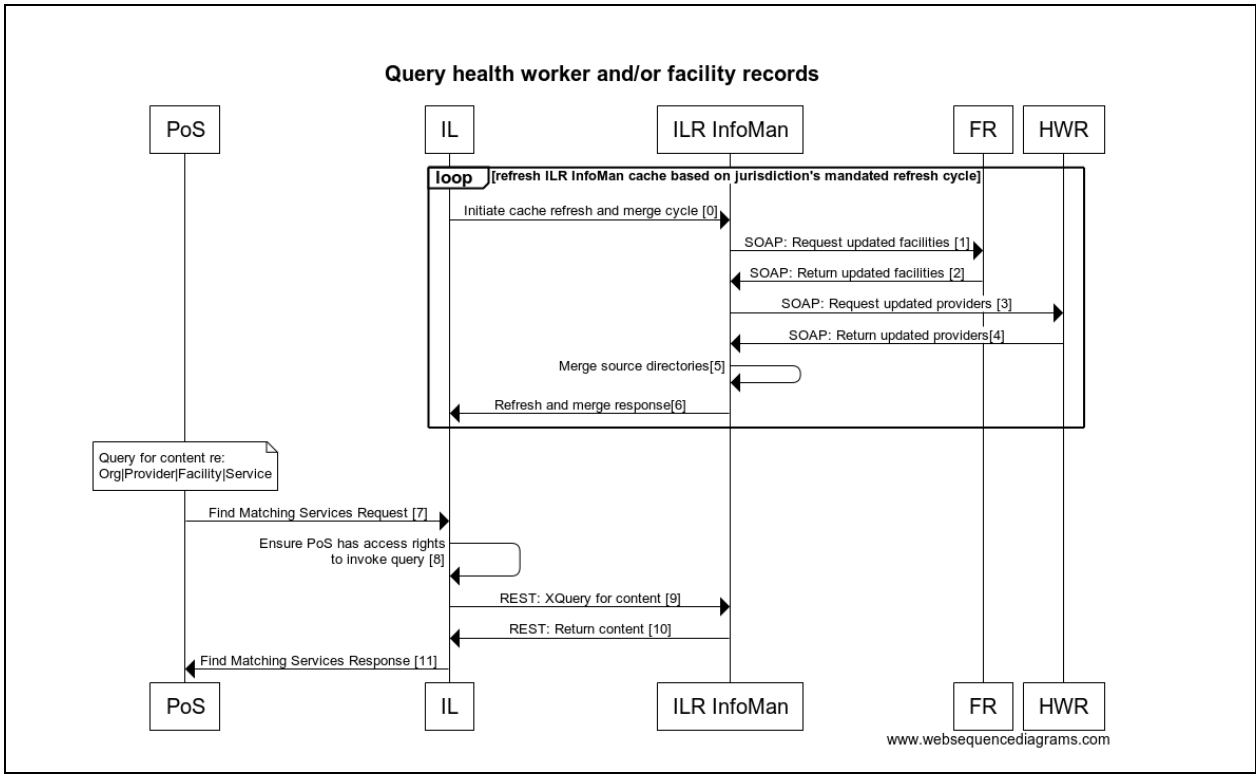
Workflow for a point of service application to query the Info Manager for health workers, facilities and/or the services provided by each.

Workflow Maturity	 Maturing	• Workflow is defined and ARB Approved • Workflow is supported by CSD IHE standards*
Standards*	Care Services Discovery (CSD): ftp://ftp.ihe.net/DocumentPublication/CurrentPublished/ITInfrastructure/IHE_ITI_Suppl_CSD.pdf	
Assumptions and Prerequisites	None	
Actors	• IL = Interoperability Layer to handle data governance and security issues, CSD Services Finder • POS = Point of Service Application, CSD Services Finder • ILR InfoMan = Interlinked Registries CSD InfoManager • HWR = Health Worker Registry HWR, CSD Services Directory • FR = Facility Registry FR, CSD Services Directory	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.4.1.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data / Notes	Transaction Options
0	Initiated according to timing set by jurisdiction	HTTP GET Request. No query parameters required.	
1	Request Added / Updated facilities	POST SOAP wrapped message with last time service directory was polled	[ITI-74] Query for Updated Services Transaction

2	Return Added / Updated facilities	SOAP wrapped CSD document with updates to services (facilities)	[ITI-74] Query for Updated Services Transaction
3	Request Added / Updated Providers	SOAP wrapped message with last time service directory was polled	[ITI-74] Query for Updated Services Transaction
4	Return Added / Updated Providers	SOAP wrapped CSD document with updates to services (health workers)	[ITI-74] Query for Updated Services Transaction
5	Merge Facilities and Providers	(Optional) Merge caches of FR and HWR according to jurisdiction specific data governance/conflict resolution policy	
6	Merge response	HTTP 200 Response on success. HTTP 500 Response on failure	
7	Find Matching Services Request	POST careServicesRequest document defined in CSD.xsd	[ITI-73] Find Matching Services (Ad-Hoc and Stored)
8	Ensure PoS has access rights	@uuid attribute in careServicesRequest document for stored queries is used for validation	Validation is defined according to country specific Data governance policies in accessing the InfoMan
9	XQuery for content	POST careServicesRequest	[ITI-73] Find Matching Services (Ad-Hoc and Stored)

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

		document defined in CSD.xsd	
10	Return content	Result of executing stored referencced by uuid/ad-hoc xquery. Usually a CSD document but can have any content-type depending on the query requested.	[ITI-73] Find Matching Services (Ad-Hoc and Stored)
11	Find Matching Services Response	Result of executing stored referencced by uuid/ad-hoc xquery. Usually a CSD document but can have any content-type depending on the query requested.	[ITI-73] Find Matching Services (Ad-Hoc and Stored)

4.4.2 Query Care Services Records Workflow

Workflow for a point of service application to query the Info Manager for the care services provided by each.

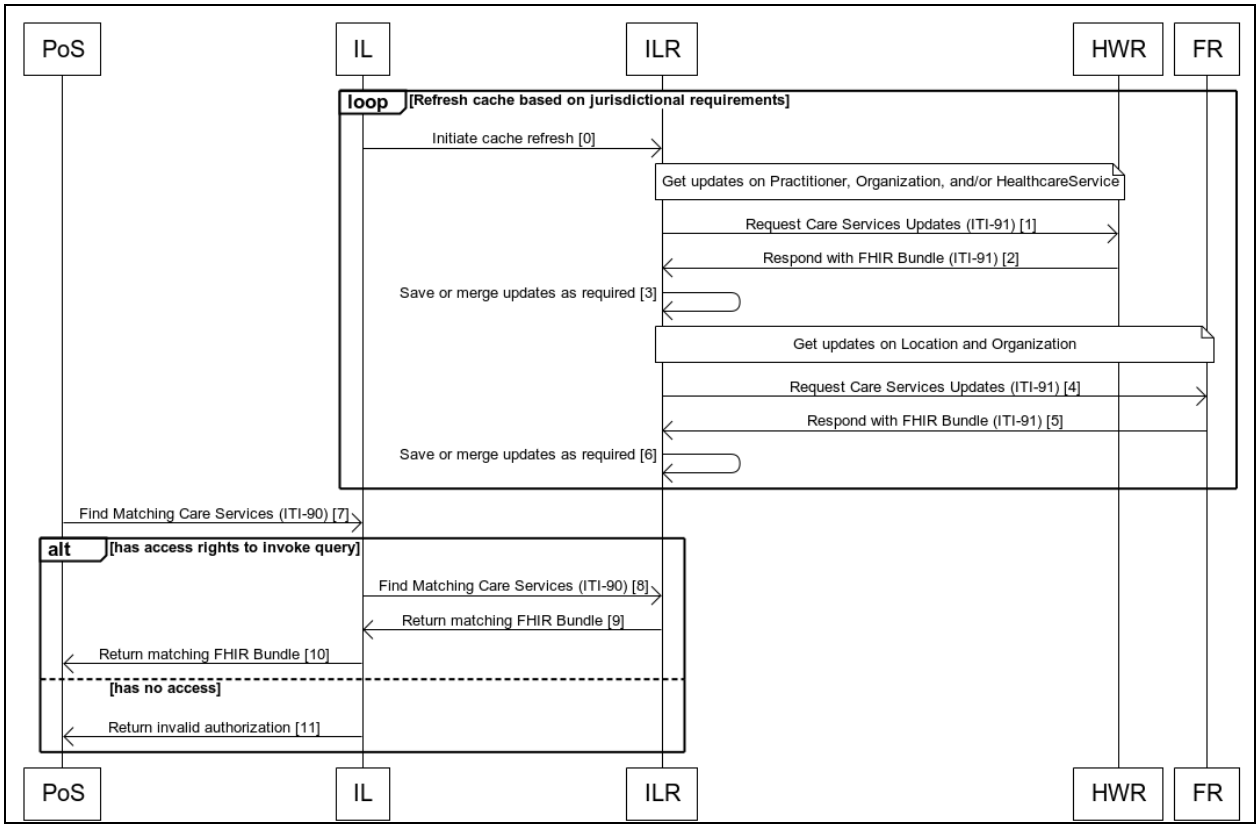
Workflow Maturity	 Maturing	• Workflow is defined and ARB Approved • Workflow is supported by emerging IHE mCSD standard
Standards*	Mobile Care Services Discovery (mCSD): ftp://ftp.ihe.net/DocumentPublication/CurrentPublished/ITInfrastructure/IHE_ITI_Suppl_mCSD.pdf	
Assumptions and Prerequisites	A Care Services Registry shall have one or more of the following resources: • Location • Practitioner and PractitionerRole • Organization • HealthcareService	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

Actors	• IL = Interoperability Layer to handle data governance and security issues, mCSD Care Services Selective Supplier • PoS = Point of Service Application, mCSD Care Services Selective Consumer • ILR InfoMan = Interlinked Registries mCSD Care Services Update Consumer and Care Services Selective Supplier • HWR = Health Worker Registry HWR, mCSD Care Services Update Supplier • FR = Facility Registry FR, mCSD Care Services Update Supplier

4.4.2.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data / Notes	Transaction Options
0	Initiated according to timing set by jurisdiction	HTTP GET Request. No query parameters required.	
1	Request Added / Updated healthcare worker data	HTTP GET Request. Optional parameter since a requested time.	[ITI-91] Request Care Services Updates Request
2	Return Added / Updated healthcare worker data	HTTP response with FHIR Bundle.	[ITI-91] Request Care Services Updates Response
3	Save or Merge healthcare worker data	Save or optionally merge updated data based on jurisdictional requirements.	
4	Return Added / Updated facility data	HTTP GET Request. Optional parameter since a requested time.	[ITI-91] Request Care Services Updates Request
5	Return Added / Updated healthcare worker data	HTTP response with FHIR Bundle.	[ITI-91] Request Care Services Updates Response
6	Save or Merge healthcare worker data	Save or optionally merge updated data based on jurisdictional requirements	
7	Search for matching interlinked	HTTP GET Request with optional query parameters. Can be	[ITI-90] Find Matching Care Services Request

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

	data from PoS to IL.	for any supported resources.	
8	Forward search for matching interlinked data from IL to ILR if access is allowed.	HTTP GET Request with optional query parameters. Can be for any supported resources.	[ITI-90] Find Matching Care Services Request
9	Return matching care services from ILR to IL	HTTP response with FHIR Bundle of matching resources or an error if an invalid request or server error.	[ITI-90] Find Matching Care Services Response
10	Return matching care services from IL to PoS	HTTP response with FHIR Bundle of matching resources or an error if an invalid request or server error.	[ITI-90] Find Matching Care Services Response
11	If PoS doesn't have access return error	Return invalid access error.	

4.4.3 Search Care Services Workflow

Workflow for a point of service application to query a Care Services registry for health workers, facilities, organizations, and/or the services provided by each.

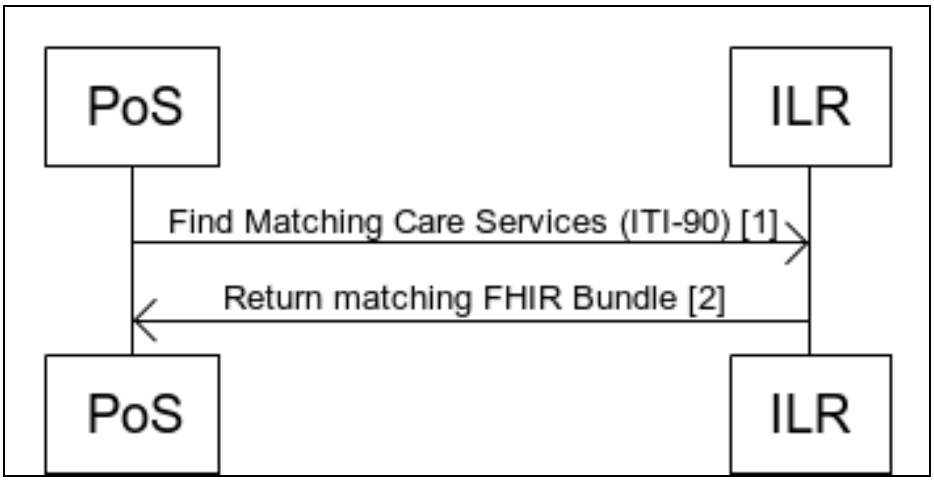
Standards*	Mobile Care Services Discovery (mCSD): ftp://ftp.ihe.net/DocumentPublication/CurrentPublished/ITInfrastructure/IHE_ITI_Suppl_mCSD.pdf
Assumptions and Prerequisites	A Care Services Registry shall have one or more of the following resources: • Location • Practitioner and PractitionerRole

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

	• Organization • HealthcareService
Actors	• PoS = Point of Service Application, mCSD Care Services Selective Consumer • ILR InfoMan = Interlinked Registry, mCSD Care Services Selective Supplier

4.4.3.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data / Notes	Transaction Options
1	Search for matching care services	HTTP GET Request with optional query parameters. Can be for any supported resources.	[ITI-90] Find Matching Care Services
2	Return matching care services	HTTP response with FHIR Bundle of matching resources or an error if an invalid request or server error.	[ITI-90] Find Matching Care Services

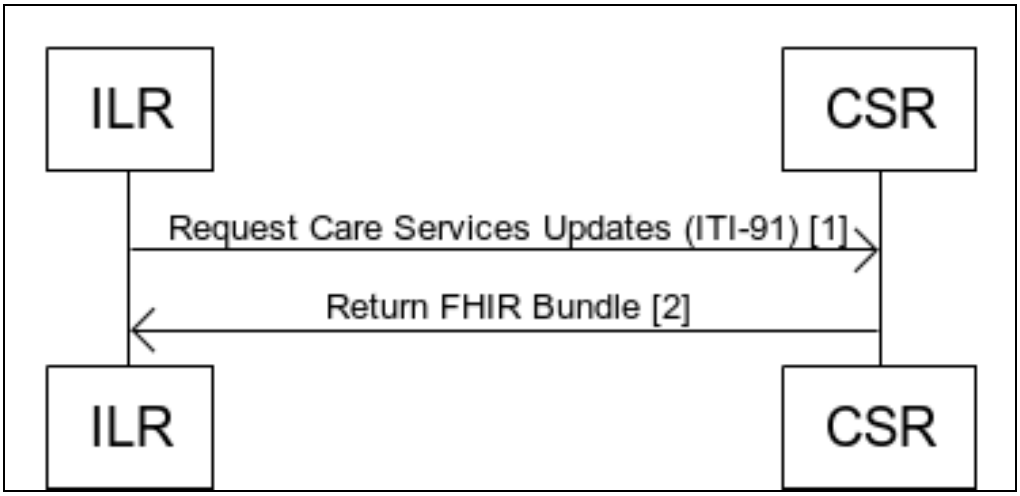
4.4.4 Request Care Services Updates Workflow

Workflow for a point of service application to query a Care Services Registry or directory for updates to health workers, facilities, organizations, and/or the services provided by each.

Workflow Maturity	Maturing	• Workflow is defined and ARB Approved • Workflow is supported by emerging IHE mCSD standard
Standards*	Mobile Care Services Discovery (mCSD): ftp://ftp.ihe.net/DocumentPublication/CurrentPublished/ITInfrastructure/IHE_ITI_Suppl_mCSD.pdf	
Assumptions and Prerequisites	A Care Services Registry shall have one or more of the following resources: • Location • Practitioner and PractitionerRole • Organization • HealthcareService	
Actors	• ILR= InterLinked Registry, mCSD Care Services Update Consumer • CSR = Any Care Services Registry (e.g. HWR or FR), mCSD Care Services Update Supplier	

4.4.4.1 Interaction Description

The following is a description of the interaction steps.



For information about IHE Standard Maturity, see the standard (see section 4.1)

#	Interaction	Data / Notes	Transaction Options
1	Request care services updates	HTTP GET Request with optional date parameter. Can be for any supported resources.	[ITI-91] Request Care Services Updates
2	Return updated care services	HTTP response with FHIR Bundle of matching resources or an error if an invalid request or server error.	[ITI-91] Request Care Services Updates

4.5 Laboratory Work Flows

The workflows are designed to support the following types of data exchanges:

- Electronic Medical Records (EMR) systems can send an electronic lab order to a laboratory information system (LIS).
- A LIS can send lab results electronically to an EMR
- For more information on exemplary implementations, please contact the LIS COP.

4.5.1 Order Laboratory Test

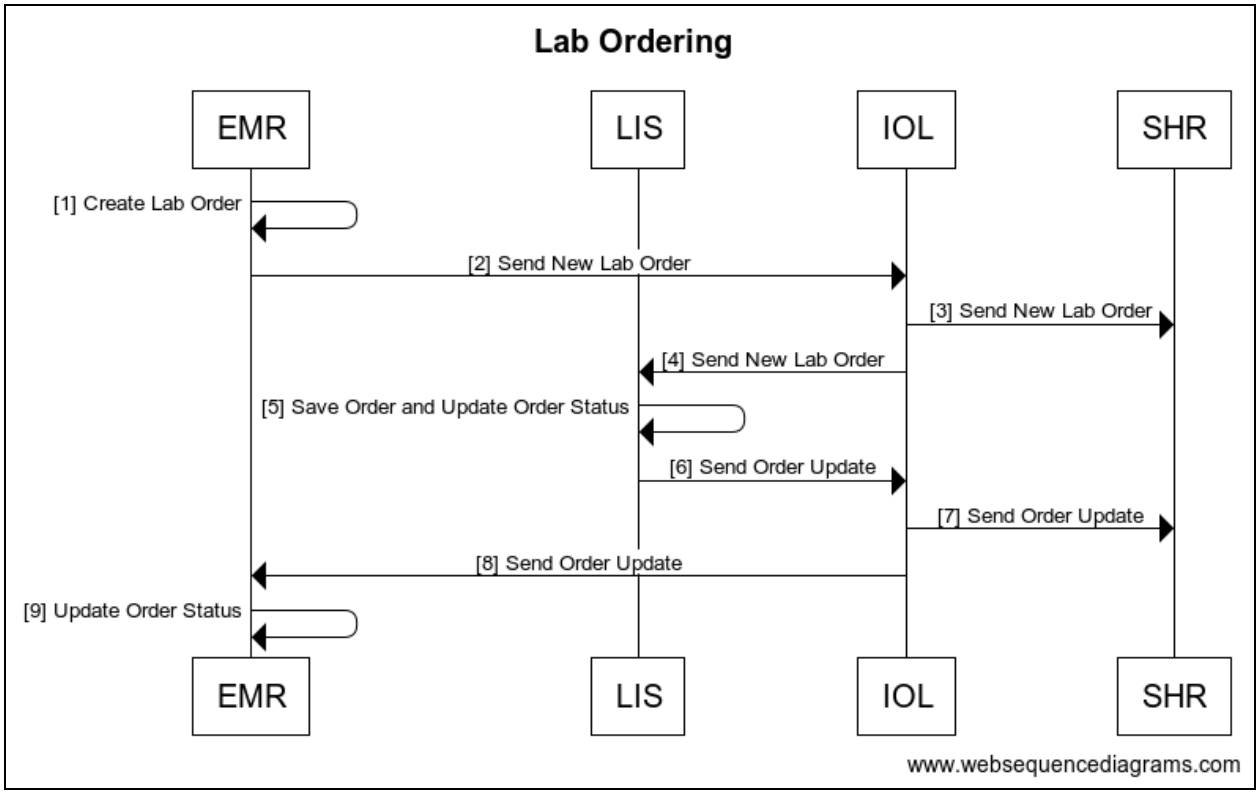
Electronic Medical Records (EMRs) systems can send an electronic lab order to a laboratory information system (LIS).

Workflow Maturity	 Newly Defined	• Workflow is defined and ARB approved • Initial implementations are being implemented
Standards	• FHIR R4 search on Task, DiagnosticReport, ServiceRequest or Patient resources • FHIR R4 bundle search response • FHIR R4 Workflow	
Assumptions and	• The EMR and LIS are trusted applications known by the IOL	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

Prerequisites	• The IOL supports node authentication, audit tracking, and rerunning of failed transactions • The SHR adheres to OHIE specification
Actors	• EMR - The electronic medical record system that captures the patient and order information and sends the electronic order to the LIS • LIS - The laboratory information system that pulls order information, processes orders, updating statuses and generating results sets • IOL - The interoperability layer that secures and orchestrates the exchange of information (see OHIE Interoperability layer) • SHR - The shared health record that serves as a centralized data store for patients' longitudinal health record

4.5.1.1 Interaction Description



#	Interaction	Data	Transaction Options
1	Create Lab Order	The order save generates a FHIR R4 Task Resource (see example here)	Alternatively, the order save could generate a FHIR R4 ServiceRequest Resource for direct transmission.
2	Send New Lab Order	FHIR Task bundled order is sent to the IOL and consists of a FHIR R4 Task Resource and a referenced FHIR R4 Patient Resource (example). Task status is aligned with the FHIR workflow communication pattern found here	FHIR R4 bundle (example) Alternatively a FHIR R4 ServiceRequest and Patient Resource bundle could be sent
3,4	Send New Lab Order	Bundled order is routed through the IOL to both the SHR and the LIS	FHIR R4 bundle (example)
5	Save Order and Update Order Status	FHIR R4 Task Resource Status is updated locally to either *rejected* or *accepted*. A FHIR R4 ServiceRequest Resource (example) is created for order processing with a reference to the associated task. EMR test requests and LIS orders are matched based on LOINC codes.	Alternatively, a ServiceRequest with a link to the referenced ServiceRequest could be populated.

6	Send Order Update	Update Task Resource Status from [5] is sent to the IOL	Alternatively, this could be an update to a FHIR R4 ServiceRequest resource
7,8	Send Order Update	IOL routes the updated FHIR R4 Tasks to the SHR and the EMR	See transaction options [6]
9	Update FHIR Task Status	FHIR task status updated locally	See transaction options [6]

4.5.2 Report Lab Results

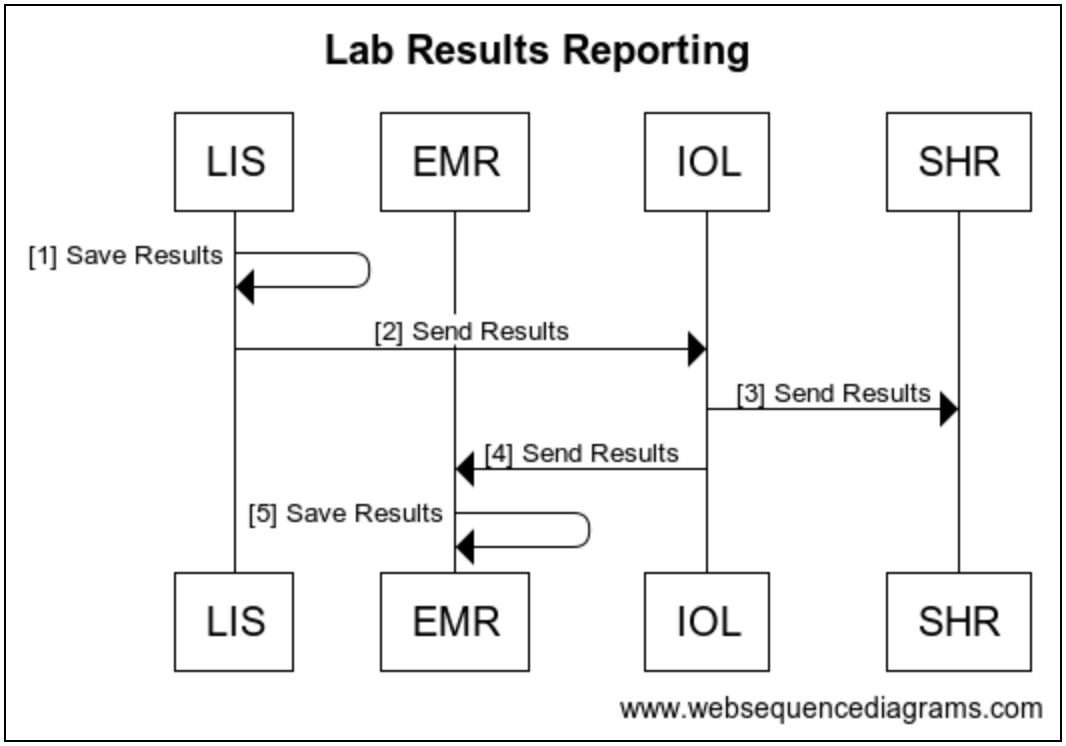
A laboratory information system (LIS) can send lab test results to an Electronic Medical Record (EMR) system.

Workflow Maturity	 Newly Defined	• Workflow is defined and ARB approved • Initial implementations are being implemented
Standards	• FHIR R4 Workflow • FHIR R4 search on Task, DiagnosticReport, ServiceRequest or Patient resources • FHIR R4 bundle search response	
Assumptions and Prerequisites	• The EMR and LIS are trusted applications known by the IOL • The IOL supports node authentication, audit tracking, and rerunning of failed transactions • The SHR adheres to OHIE specification	
Actors	• EMR - The electronic medical record system that captures the patient and order information and sends the electronic order to the LIS	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

	• LIS - The laboratory information system that pulls order information, processes orders, updating statuses and generating results sets • IOL - The interoperability layer that secures and orchestrates the exchange of information (see OHIE Interoperability layer) • SHR - The shared health record that serves as a centralized data store for patients' longitudinal health record

4.5.2.1 Interaction Description



#	Interaction	Data	Transaction Options
1	Results Saved and FHIR Task Updated	The results save generates a FHIR R4 DiagnosticReport Resource (example) with referenced FHIR R4 Observation resources (example) to store the results, and a reference to the associated Patient and Task Resource.	
2	Search for Updated FHIR Tasks		FHIR R4 Search for Tasks based on tasks for which the owner is the EMR, and which have a status 'completed'
3	Return FHIR Updated Tasks	FHIR R4 Task Resource with status 'completed' and reference to FHIR R4 DiagnosticReport	FHIR R4 bundle search response (example)
4	Search for Associated Diagnostic Reports		FHIR R4 Search for DiagnosticReports by UUID
5	Return Associated Diagnostic Reports	FHIR R4 DiagnosticReport Resource with	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

6	Update FHIR Task Status, Store DiagnosticReports and Save Results		

4.6 Patient Identity Management Workflows

The Client Registry is designed to assist in uniquely identifying individuals who receive healthcare services in the geographic region and/or use cases supported HIE.

The workflows are designed to support the following types of data exchanges:

- A Point-of-Service (PoS) systems such as EMRs or other patient identity sources can add or update a patient's demographics information in the Client Registry.
- A Point-of-Service (PoS) or other system that is authorized to access the HIE can query the Client Registry for the patient's unique id or demographic information.
- For more information on exemplary implementations, please contact the Client Registry Community.

4.6.1 Create Patient Demographic Record Workflow

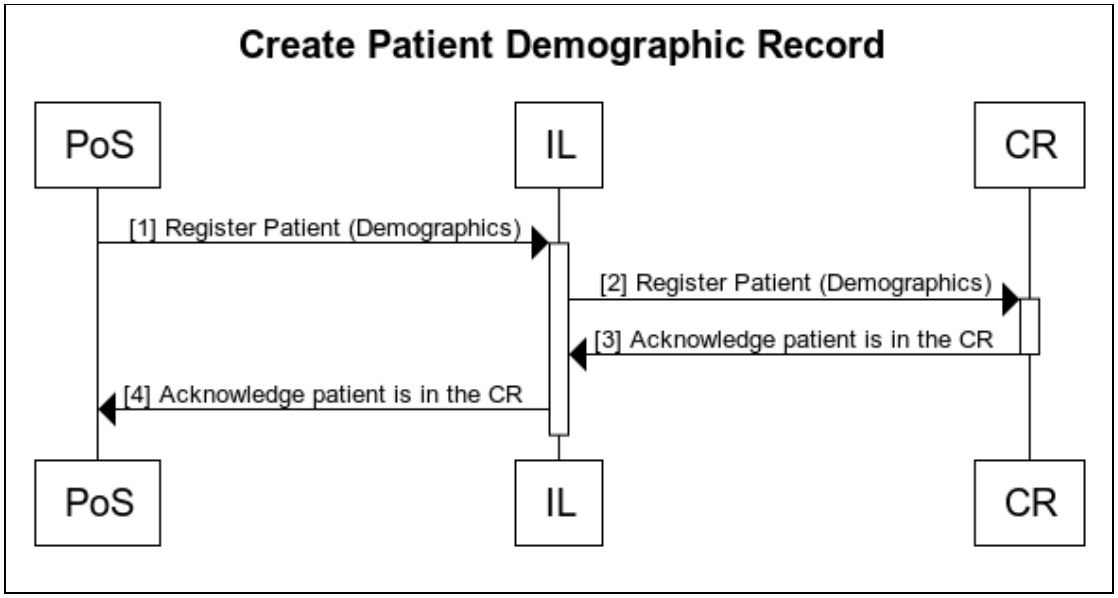
This transaction allows a Point-of-Service (PoS) system to store a patient's demographics in the Client Registry. The following sequence diagram below shows the steps that occur during this transaction.

Workflow Maturity	Mature	• Workflow is defined and ARB approved • Workflow is supported by mature standards • One or more OpenHIE implementations of this workflow exist in one or more countries
Standard(s) *	ADT^A01, ADT^A04, ADT^A05 - PIF IHE ITI-8 Transactions	
Assumptions and Prerequisites	1. The Point-of-Service (PoS) system is a trusted application known by the HIE and it is registered with the interoperability layer to be able to send and receive data securely (Common message security workflow). 2. The workflow will result in a positive acknowledgement message when the patient is successfully created in the Client Registry or if the patient already exists in the Client Registry. 3. The workflow will not register a duplicate patent if the patient already exists in the Client Registry.	

For information about IHE Standard Maturity, see the standard (see section 4.1)

Actors	• PoS - The point-of-service system that captures patient identifiers, is responsible for sending the identifiers to the HIE. • IL - Mediates the transactions between the PoS system and the Client Registry. • CR - Manages patient demographics and identifier details.

4.6.1.1 Interaction Description



#	Interaction	Data	Transaction Options
1	Register Patient (Demographics)	The message may include both identifiers and demographic attributes for the patient to be registered. The format of the message is specified by the ITI-8 IHE PIX v2 transaction and takes the form of an HL7v2.3.1 A01 (Admission of an in-patient into a facility), A04 (Registration of an outpatient for a visit of the facility), or A05 (registration of patient information ahead of actual admission) message depending on whether the message is the result of admitting and in-patient into a facility, registering an outpatient, or pre-admission of an in-patient.	PIF ITI-8 transactions ADT^A01, ADT^A04, ADT^A05 Patient Identity Feed IHE ITI-8 Transactions
2	Register Patient (Demographics)	The message from the PoS is passed directly through to the CR by the IL.	PIF ITI-8 transactions ADT^A01, ADT^A04, ADT^A05 Patient Identity Feed IHE ITI-8 Transactions
3	Acknowledge patient is in the CR	The response message is an HL7 ACK. See ITI TF-2x: C.2.3, "Acknowledgment Modes" for definition and discussion of the ACK message.	PIF ITI-8 transactions HL7 ACK Patient Identity Feed IHE ITI-8 Transactions
4	Acknowledge patient is in the CR	The message from the CR is passed directly through to the Point-of-Service by the IL.	PIF ITI-8 transactions HL7 ACK Patient Identity Feed IHE ITI-8 Transactions

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.6.2 Update Patient Demographic Record Workflow

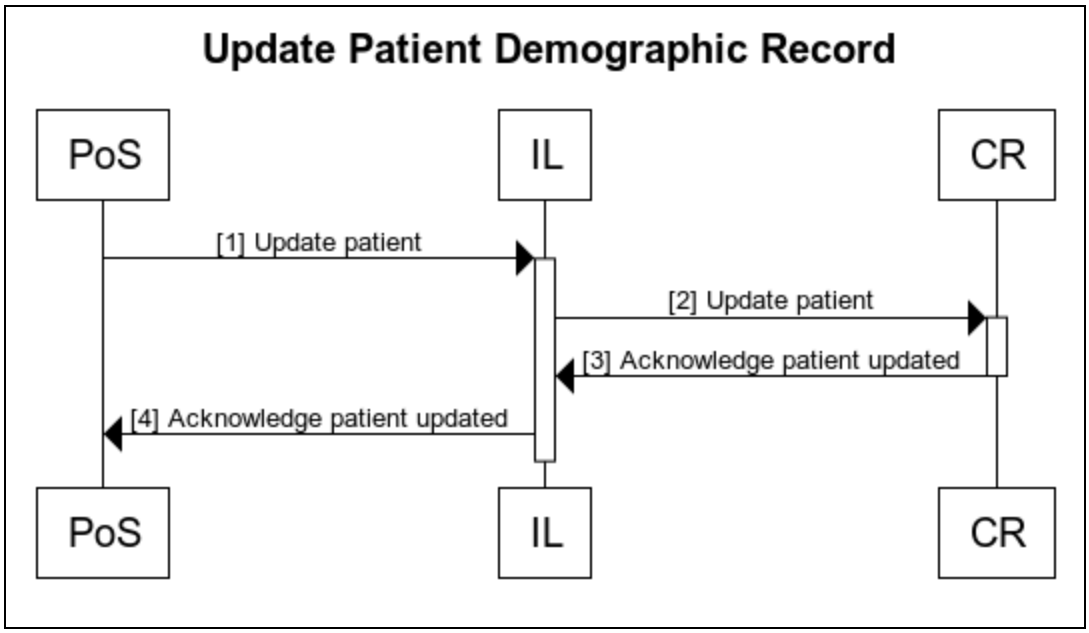
This transaction allows the Point-of-Service (PoS) systems to update a patient record in the client registry. The following sequence diagram shows the steps involved.

Workflow Maturity	Mature	• Workflow is defined and ARB approved • Workflow is supported by mature standards • One or more OpenHIE implementations of this workflow exist in one or more countries
Standards*	ADT^A08 - IHE ITI-8 Transactions	
Assumptions and Prerequisites	• The Point-of-Service system is a trusted application known by the HIE and it is registered with the interoperability layer to be able to send and receive data securely (Common message security workflow). • The Patient to be updated is assumed to already exist in the Client Registry.	
Actors	• PoS - The point of care system that captures patient identifiers, is responsible for sending the identifiers to the HIE. • IL - Mediates the transactions between the PoS system and the Client Registry. • CR - Manages patient demographics and identifier details.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.6.2.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	Update patient	The format of the message is specified by the ITI-8 IHE PIX v2 transaction and takes the form of an HL7v2.3.1 A08 message. The message may include both identifiers and demographic attributes for the patient to be updated.	PIF ITI-8 transaction ADT^A08 Patient Identity Feed IHE ITI-8 Transactions
2	Update patient	The message from the Point-of-Service system is passed directly through to the CR by the IL.	PIF ITI-8 transaction ADT^A08 Patient Identity Feed IHE ITI-8 Transactions
3	Acknowledge patient updated	The response message is an HL7 ACK. See ITI TF-2x: C.2.3, "Acknowledgment Modes" for definition and discussion of the ACK message.	PIF ITI-8 transactions HL7 ACK Patient Identity Feed IHE ITI-8 Transactions

4	Acknowledge patient updated	The message from the CR is passed directly through to the PoS by the IL.	PIF ITI-8 transactions HL7 ACK Patient Identity Feed IHE ITI-8 Transactions

4.6.3 Query Patient Demographic Records By Identifier Workflow

This transaction allows patient demographics to be fetched from the Client Registry using an identifier. The following sequence diagram shows the steps involved.

Workflow Maturity	Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards

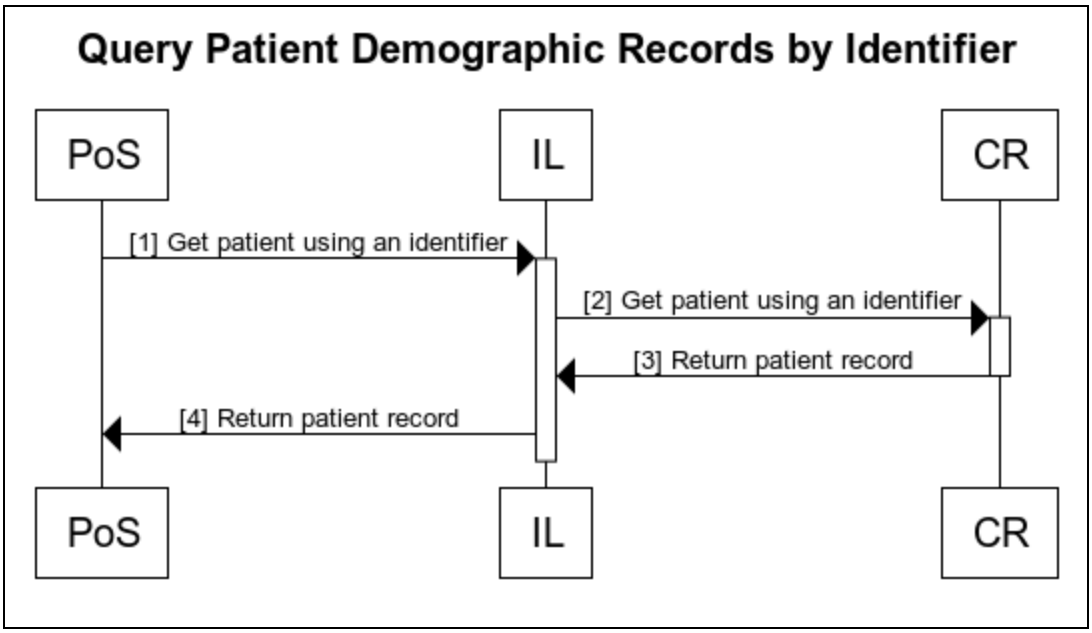
Standards*	• Option 1
	  • QBP^Q22 - IHE ITI-21
	  • RSP^K22 - IHE ITI-21
	• Option 2
	  • FHIR - Patient Demographics Query IHE ITI PDQm Transaction	

Assumptions and Prerequisites	• The PoS system is a trusted application known by the HIE and it is registered with the interoperability layer to be able to send and receive data securely (Common message security workflow).	
Actors	• PoS - The point of service system that captures patient identifiers, is responsible for sending the identifiers to the HIE. • IL - Mediates the transactions between the PoS system and the client registry. • CR - Manages patient demographics and identifier details.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.6.3.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	Get patient by identifier	The message includes the query criteria, which may include one or more patient identifiers.	• PDQ ITI-21 transaction QBP-Q22 OR • Patient Demographics Query IHE ITI PDQm Transaction
2	Get patient from CR by identifier	The message from the PoS is passed directly through to the CR by the IL	• PDQ ITI-21 transaction QBP-Q22 OR • Patient Demographics Query IHE ITI PDQm Transaction
3	Return patient record	The response returns the patient(s) that matched the query criteria. It may consist of zero or more	• PDQ ITI-21 transaction RSP-K22 OR • Query Patient Resource Response (ITI TF-2c:3.Y1.4.2): Bundle (Patient)

		patient demographic records.	
4	Return patient record	The message from the CR is passed directly through to the PoS by the IL	• PDQ ITI-21 transaction RSP-K22 OR • Query Patient Resource Response (ITI TF-2c:3.Y1.4.2): Bundle (Patient)

4.6.4 Query Patient Demographic Records by Demographics Workflow

This transaction allows Point-of-Service (PoS) systems to query for patients that match supplied demographics. The following sequence diagram shows the steps involved.

Workflow Maturity	Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards*	Option 1 • QBP^Q22 - IHE ITI-21 • RSP^K22 - IHE ITI-21 Option 2 • FHIR - Patient Demographics Query IHE ITI PDQm Transaction	
Assumptions and Prerequisites	• The PoS system is a trusted application known by the HIE and it is registered with the interoperability layer to be able to send and receive data securely (Common message security workflow).	
Actors	• PoS - The point of care system that captures patient identifiers, is responsible for sending the identifiers to the HIE. • IL - Mediates the transactions between the PoS system and the client registry. • CR - Manages patient demographics and identifier details	

4.7 Shared Health Record

This collection of workflows allows an external system with access to the HIE to save and retrieve information from the HIE.

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

The workflows are designed to support the following types of data exchanges with systems that have authority to access the HIE:

1. A point-of-care or external system can query for previous encounters for a specific patient.
2. This transaction allows a PoC or an external system to provide data to the HIE's SHR.
3. A point-of-care or external system can request and receive an on-demand document from the HIE's SHR.

4.7.1 Save Patient-level Clinical Data Workflow

This transaction allows a point of service (PoS) system to save patient-level clinical data to the SHR. The transaction is verified and validated against the other registries before it is saved in the SHR. The following sequence diagram shows the steps involved.

Workflow Maturity	 Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards*

Standards	• XDS.b with the on-demand document (ODD) option - provide and register document - ITI-41
	• CDA documents profiled by IHE PCC as the clinical data
	• CSD - Find matching services - ITI-73
	• PIX Query - ITI-9
	• **Optionally,** the MHD (FHIR-based) profile may be used instead of the XDS.b profile to enable PoC systems to save clinical content using a simpler and more modern approach. This option may be supported in two ways:
	  ○ The SHR itself may support the required MHD transactions.
	  ○ The IL can provide an adapter to convert incoming MHD transactions to XDS.b transactions for the SHR to process as normal.	

Assumptions and Prerequisites	• The PoS system has a curated list of Providers that interact with that system, with knowledge of at least the providers that are relevant to that PoS system. • The PoS system has a curated list of Facilities that this system serves, with knowledge of at least one member (itself). • The PoS system must ensure the patient they are submitting clinical information about already exists. It can do this by querying for the patient and if they don't exist they should register them (Create patient	

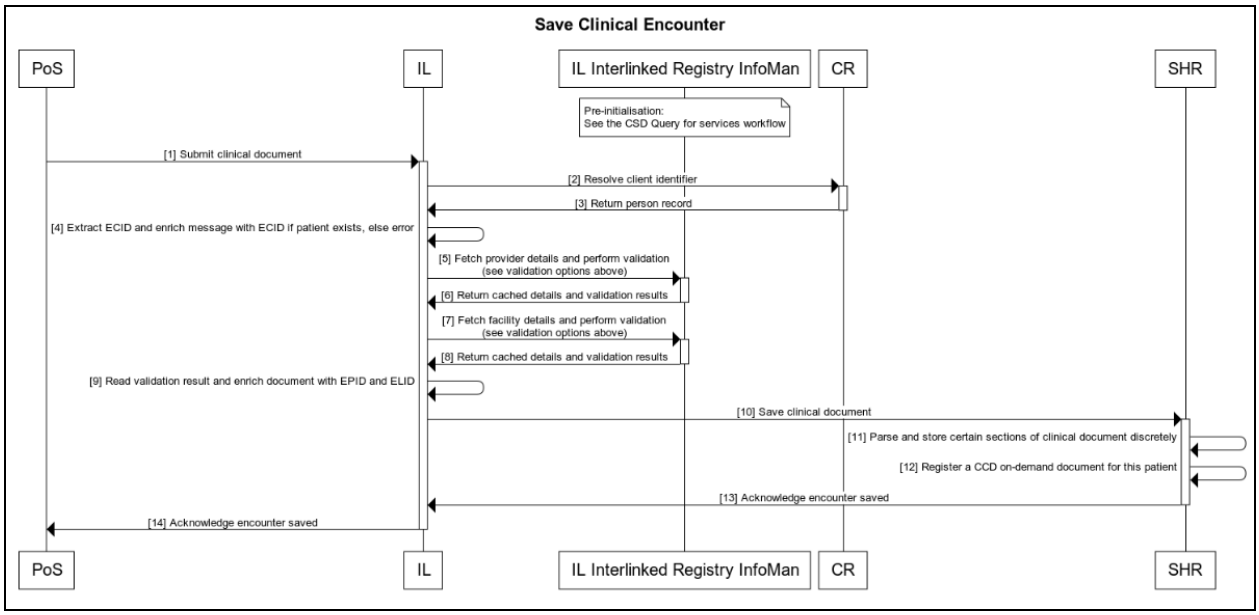
For information about IHE Standard Maturity, see the standard (see section 4.1)

	demographic record workflow). • The PoS system is a trusted application known by the HIE and it is registered with the interoperability layer to be able to send and receive data securely (Common message security workflow). • The conditions for the validation of facility, provider and services are configurable to enable them to be more or less strict. • All XDS submissions to the IL MUST contain author information. Either authorPerson or authorInstitution or both MUST be supplied. When supplying these, they MUST be supplied in full XCN/XON format and these MUST include an identifier component. This requirement is more restrictive than the XDS.b profile, however it is required in order to perform validation of the health worker and facility submitting this information. • The SHR **MUST** be able to store certain sections of a CDA document as discrete data in its internal data model for use when generating on-demand documents. The sections that are to be supported for discrete import are those defined in the XDS-MS specification, as well as (optionally) any other section that is deemed useful within the environment in which the SHR is deployed.
Actors	• PoS - The point of service system that captures a patient clinical encounter, it is responsible for sending this encounter on to the HIE. • IL - Mediates the transactions between the PoS system and the infrastructure services to facilitate easier interoperability. • CR - The source of truth for patient demographic and identifier detail. It is able to be queried using an identifier to find the enterprise identifier

	for a particular person. • IL (Interlinked Registry) - The source of truth for facility information. It is able to be queried for details about a particular facility by ID. In implementations, the FR and/or the HWR can be used if the IL is not required for linking health workers and facilities. • SHR - Stored patients clinical information. It is able to receive and store a patient clinical documents.

4.7.1.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	Submit clinical encounter	CDA document conforming to a particular PCC profile XDS.b provide and register document (ITI-41 from the ITI framework) - SOAP web service	XDS: IHE IT Infrastructure Vol. 1 - Section 10, Appendix E, J, K Vol. 2a - Sections 3.18 Vol. 2b - Sections 3.41, 3.42, 3.43

		and optionally MHD provide document bundle (ITI-65) - RESTful FHIR interface	Vol. 2x - Appendix A, B, K, L, M, N, V, W Vol. 3 - Section 4.1, 4.2, 4.3 MHD: MHD profile supplement
2	Resolve client identifier	HL7 QBP^Q23 message	IHE IT Infrastructure PIX Query (ITI-9) Vol. 1 - Section 5 Vol. 2 - Sections 3.9
3	Return person record	HL7 RSP^K23 message	
4	Extract ECID and enrich message with ECID if patient exists, else error		
5	Fetch provider details and perform validation	Function urn='urn:ihe:iti:csd:2014:stored-function:provider-search'	IHE ITI CSD Supplement
6	Return cached details and validation results	Return validation results	
7	Fetch facility details and perform validation	Function urn='urn:ihe:iti:csd:2014:stored-function:facility-search'	IHE ITI CSD Supplement
8	Return cached details and validation results		

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

9	Read validation result and enrich document with EPID and ELID		
10	Save clinical encounter	CDA document conforming to a particular PCC profile XDS.b provide and register document (ITI-41 from the ITI framework) - SOAP web service and optionally MHD provide document bundle (ITI-65) - RESTful FHIR interface	IHE IT Infrastructure Vol. 1 - Section 10, Appendix E, J, K Vol. 2a - Sections 3.18 Vol. 2b - Sections 3.41, 3.42, 3.43 Vol. 2x - Appendix A, B, K, L, M, N, V, W Vol. 3 - Section 4.1, 4.2, 4.3 MHD: MHD profile supplement
11	Parse and store certain sections of clinical document discretely		
12	Register a CCD on-demand document for this patient	Generated metadata	IHE IT Infrastructure Vol. 1 - Section 10, Appendix E, J, K Vol. 2a - Sections 3.18 Vol. 2b - Sections 3.41, 3.42, 3.43 Vol. 2x - Appendix A, B, K, L, M, N, V, W Vol. 3 - Section 4.1, 4.2, 4.3 XDS-MS specification
13	Acknowledge encounter saved	ITI-41 SOAP response and optionally ITI-65 RESTful response	
14	Acknowledge encounter saved	ITI-41 SOAP response and optionally ITI-65 RESTful response	

4.7.2 Query Patient-level Clinical Data Workflow

The transaction queries for previously stored clinical data for a specific patient. The following sequence diagram shows the steps involved in this transaction.

Workflow Maturity	Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards

Standards*	• XDS.b with the on-demand document option
	• CDA documents profiled by IHE PCC
	• CSD - Find matching services - ITI-73
	• PIX Query - ITI-9
	• **Optionally,** the MHD profile can be supported (in addition or instead of XDS.b) to enable PoC systems to query clinical content using a simpler and more modern FHIR-based approach. This option may be supported in two ways:
	  • The SHR itself may support the required MHD transactions.
	  • (**recommended**) The IL can provide an adapter to convert incoming MHD transactions to XDS.b transactions for the SHR to process as normal.	

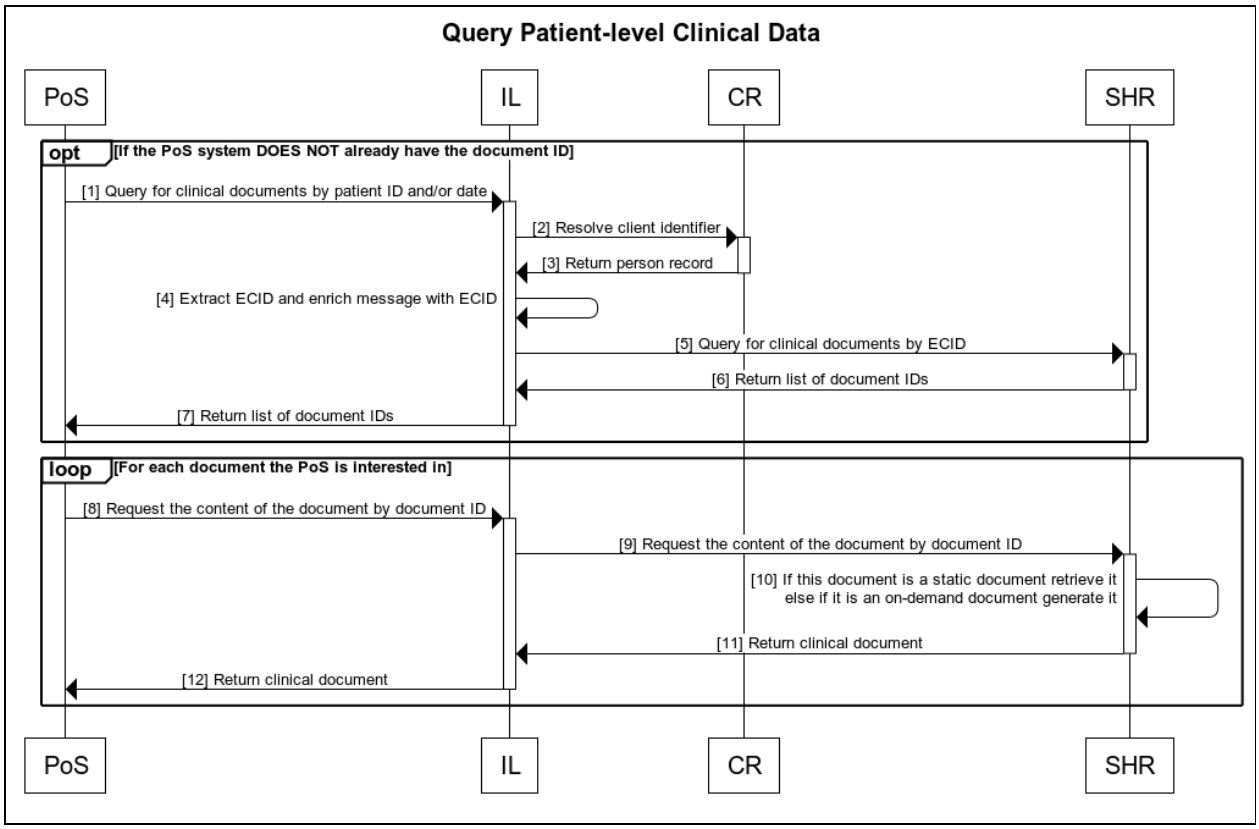
Assumptions and Prerequisites	• The PoS system must ensure the patient they are querying clinical information about already exists. It can do this by querying for the patient (Query patients workflow). • The PoS system is a trusted application known by the HIE and it is registered with the interoperability layer to be able to send and receive data securely (Common message security workflow). • The SHR **MUST** be able to generate on-demand documents in the XDS-MS format using the data it stored in the save patient-level clinical data workflow. Optionally, any other sections that have been discretely imported and are deemed useful may be added to the generated XDS-MS document.	
Actors	• PoS - The point of care system that captures a patient's clinical encounter, it is responsible for sending clinical data on to the HIE. • IL - Mediates the transactions between the PoS system and the infrastructure services to facilitate easier interoperability. • CR - The source of truth for patient demographic and identifier detail. It is able to be queried using an identifier to find the enterprise identifier for a particular person.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

	• FR - The source of truth for facility information. It is able to be queried for details about a particular facility by ID. • SHR - Stored patients clinical information. It is able to receive and store patient clinical documents.

4.7.2.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	Query for clinical documents by patient ID and/or date	XDS.b/MHD metadata Option 1 (must be supported): XDS.b Registry Stored Query (ITI-18) - Find Documents query OR	IHE IT Infrastructure Vol. 1 - Section 10, Appendix E, J, K Vol. 2a - Sections 3.18 Vol. 2b - Sections 3.41, 3.42, 3.43

		Option 2 (may additionally choose to support): MHD Find document references (ITI-67) - RESTful query	Vol. 2x - Appendix A, B, K, L, M, N, V, W Vol. 3 - Section 4.1, 4.2, 4.3 If supporting the MHD Option: MHD profile supplement
2	Resolve client identifier	HL7 QBP^Q23 message	PIX Query (ITI-9) IHE IT Infrastructure Vol. 1 - Section 5 Vol. 2 - Sections 3.9
3	Return person record	HL7 RSP^K23 message	
4	Extract ECID and enrich message with ECID		
5	Query for clinical documents by ECID	XDS.b/MHDmetadata XDS.b Registry Stored Query (ITI-18) - Find Documents query and optionally (only if SHR support MHD directly) MHD Find document references (ITI-67) - RESTful query	IHE IT Infrastructure Vol. 1 - Section 10, Appendix E, J, K Vol. 2a - Sections 3.18 Vol. 2b - Sections 3.41, 3.42, 3.43 Vol. 2x - Appendix A, B, K, L, M, N, V, W Vol. 3 - Section 4.1, 4.2, 4.3 MHD: MHD profile supplement
6	Return list of document IDs	XDS.b Registry Stored Query response - list of document IDs or optionally (only if SHR support MHD directly) MHD Find document references response - list of document IDs	

7	Return list of document IDs	XDS.b Registry Stored Query response - list of document IDs or optionally MHD Find document references response - list of document IDs	
8	Request the content of the document by document ID	XDS.b/MHDmetadata XDS.b Retrieve Document Set (ITI-43) and optionally MHD Retrieve document (ITI-68)	IHE IT Infrastructure Vol. 1 - Section 10, Appendix E, J, K Vol. 2a - Sections 3.18 Vol. 2b - Sections 3.41, 3.42, 3.43 Vol. 2x - Appendix A, B, K, L, M, N, V, W Vol. 3 - Section 4.1, 4.2, 4.3 MHD: MHD profile supplement
9	Request the content of the document by document ID	XDS.b/MHDmetadata XDS.b Retrieve Document Set (ITI-43) and optionally (only if SHR support MHD directly) MHD Retrieve document (ITI-68)	IHE IT Infrastructure Vol. 1 - Section 10, Appendix E, J, K Vol. 2a - Sections 3.18 Vol. 2b - Sections 3.41, 3.42, 3.43 Vol. 2x - Appendix A, B, K, L, M, N, V, W Vol. 3 - Section 4.1, 4.2, 4.3 MHD: MHD profile supplement
10	If this document is a static document retrieve it else if it is an on-demand document generate it		For ODD: XDS-MS Specification

11	Return clinical document	XDS.b/MHDresponse - with CDA document content	
12	Return clinical document	XDS.b/MHDresponse - with CDA document content	

4.8 Terminology Service Workflows

This collection of workflows is being designed to support terminology service interactions within or external to the HIE.

The workflows are designed to support the following types of data exchanges with systems that have access to the HIE.

1. A system can query for Code Systems, Value Sets, and Concept Maps that are present in the HIE's Terminology Service.
2. A system can verify (validate) that a code exists in a Code System or Value Set.
3. A system can lookup (retrieve the details of) a code in a Code System.
4. A system can query for the members of a Value Set.
5. A system can query for a translation of a code in one Code System to a code in another (a “mapping”)

4.8.1 Expand Value Set

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service and retrieve the set of all Concepts in the Value Set. Rather than testing each code contained in an incoming patient data message for Value Set membership, this operation enables a component to "cache" the Value Set members and test individual membership locally, avoiding extensive network overhead. Due to the likely updating of Value Set definitions, on the other hand, components should periodically refresh their local copy of the expansion.

Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

1. Expansion: Retrieve the set of Concept Codes that are members of the HIV Value Set.

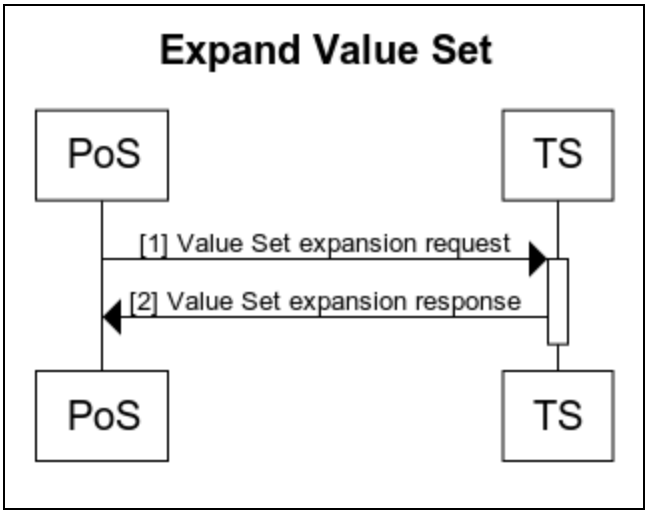
Workflow Maturity	Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards*	The FHIR ValueSet *expand* operation: http://build.fhir.org/valueset-operation-expand.html. HL7 FHIR Specifications v3.0 or higher support *expand*. The response is Value Set Resource that contains a	

For information about IHE Standard Maturity, see the standard (see section 4.1)

	collection of all the Concepts in the Value Set. If Concept attributes are to be returned with the collection, the attributes can be specified in the *expand* request. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Expand Value Set ITI-Y3.
Assumptions and Prerequisites	The required ValueSets and associated CodeSystems have been preloaded into the Terminology Service.
Actors	• PoS - The point-of-service system or any other HIE component that is requesting the expansion. • TS - Stores the curated, official version of the Value Set for the health system.

4.8.1.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	ValueSet expansion request	The expand request is triggered by a PoS or other HIE component. Input: The target ValueSet.	FHIR ValueSet Resource, $expand operation

2	ValueSet expansion response	The response is sent back to the requesting system. Output: a ValueSet Resource containing the list of Concept members.	FHIR ValueSet Resource, $expand operation

4.8.2 Translate Code

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service and retrieve the translation, or "mapping" of a Concept in one Code System to a Concept in another Code System. Mapping is frequently required when patient data is collected using Concepts/Codes from one Code System but the data must be reported or aggregated, say for decision support, in a different Code System. The set of such associated Concepts, usually for a specific use-case, are stored in the Terminology Service in a FHIR Resource called a ConceptMap.

Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

1. Mapping: Using the ConceptMap 'ICD-10 to SNOMED CT Diseases', retrieve the SNOMED CT Concept Code(s) that is associated with '123XYZ' in ICD-10.

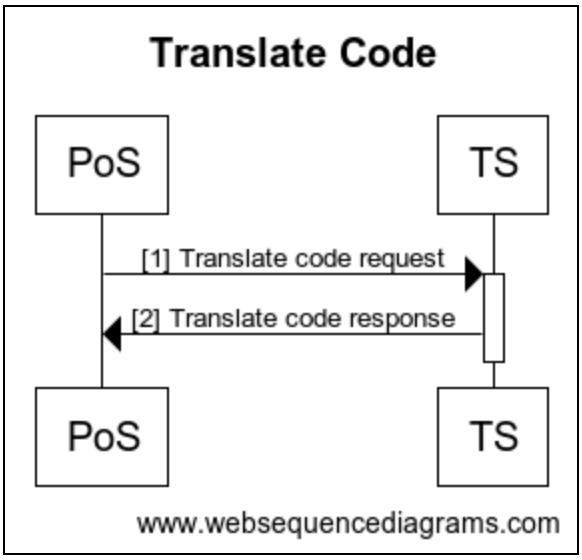
Workflow Maturity	 Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards*	The FHIR ConceptMap *translate* operation: http://build.fhir.org/conceptmap-operation-translate.html. HL7 FHIR Specifications v3.0 or higher support *translate*. The response is a set of FHIR Parameter objects that include a 'result' (whether there is an acceptable match) and a list of possible matches. The list of matches may include notes of Codes for which mappings are specifically excluded, and qualifications on the applicability of matches. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Translate Code ITI-Y7.	
Assumptions and Prerequisites	The required ConceptMap and associated CodeSystem(s) have been preloaded into the Terminology Service.	

For information about IHE Standard Maturity, see the standard (see section 4.1)

Actors	• PoS - The point-of-service system or other HIE component that is requesting the translation. • TS - Stores the curated, official version of the ConceptMap for the health system.

4.8.2.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	ConceptMap translate request	The translate request is triggered by a PoS or other HIE component. Input: The ConceptMap name and source Code and CodeSystem.	FHIR ConceptMap Resource, $translate operation
2	ConceptMap translate response	The response is sent back to the requesting system. Output: a set of parameters including a Boolean 'result, and a list of, possibly qualified, Code matches.	FHIR ConceptMap Resource, $translate operation

4.8.3 Verify Code Existence

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service to verify that a code exists. A typical example would be to validate that the codes contained in an incoming patient data message are, in fact, from a required code system, e.g. ICD-10 or LOINC.

Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

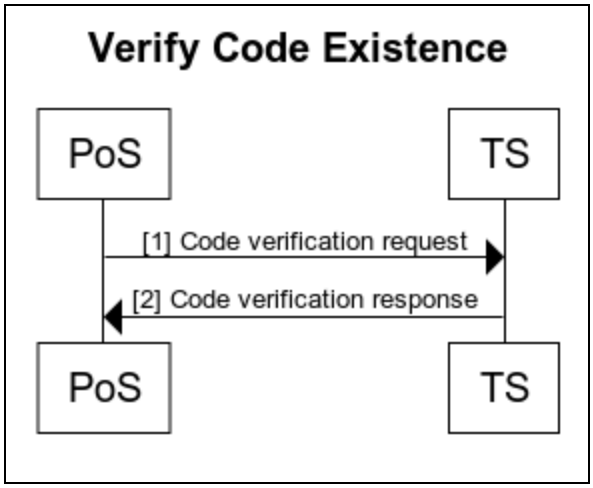
1. Existence: Is a Concept Code present in a specified Code System. E,g., is '123XYZ' a valid Code in the ICD-10 Code System?

Workflow Maturity	Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards*	The FHIR CodeSystem *validate-code* operation: http://build.fhir.org/codesystem-operation-validate-code.html. HL7 FHIR Specifications v3.0 or higher support *validate-code*. The response is a Boolean (true or false) based on whether the code exists in the specified CodeSystem. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Validate Code ITI-Y5 for Code Systems.	
Assumptions and Prerequisites	The required CodeSystems have been preloaded into the Terminology Service.	
Actors	• PoS - The point-of-service system or other HIE component that is requesting to verify a code. • TS - Stores the curated official version of the terminology and codes for the health system.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.8.3.1 Interaction Description

The following is a description of the interaction steps.



Ref	Interaction	Data	Transaction Options
1	Code verification request	The validate-code request is triggered by a PoS or other HIE component. Input: A Concept Code and target Code System.	FHIR CodeSystem Resource, $validate-code operation
2	Code verification response	The response is sent back to the requesting system. Output: a True or False response.	FHIR CodeSystem Resource, $validate-code operation

4.8.4 Verify Code Membership

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service to verify that a code is a member of defined value set. A typical example would be to validate that the codes contained in an incoming patient data message are, in fact, from a required value set, e.g. the HIV ValueSet.

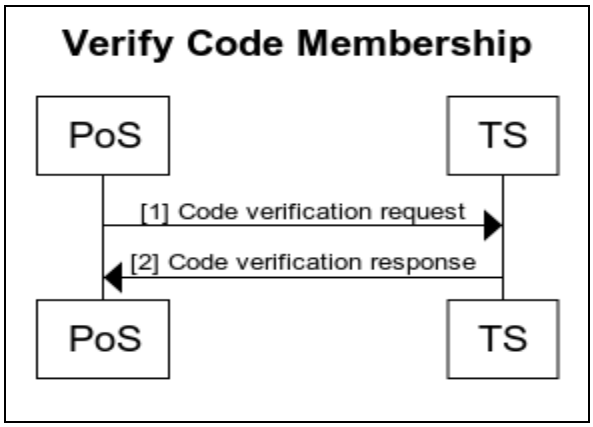
Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

1. Membership: Is a Concept Code present in a specified Value Set, e.g., is Code '123XYZ' from ICD-10 a member of the HIV ValueSet?

Workflow Maturity	Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards	The FHIR ValueSet *validate-code* operation: http://build.fhir.org/valueset-operation-validate-code.html. HL7 FHIR Specifications v3.0 or higher support *validate-code*. The response is a Boolean (true or false) based on whether the code is a member of the specified ValueSet. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Validate Code ITI-Y5 for Value Sets.	
Assumptions and Prerequisites	The required ValueSets and associated CodeSystems have been preloaded into the Terminology Service.	
Actors	• PoS - The point-of-service system or other HIE component that is requesting to verify a code. • TS - Stores the curated, official version of the Value Set for the health system.	

4.8.4.1 Interaction Description

The following is a description of the interaction steps.



**For information about IHE Standard Maturity, see the standard (see section 4.1)*

#	Interaction	Data	Transaction Options
1	Code verification request	The validate-code request is triggered by a PoS or other HIE component. Input: A Concept Code, associated Code System and target ValueSet.	FHIR ValueSet Resource, $validate-code operation
2	Code verification response	The response is sent back to the requesting system. Output: a True or False response.	FHIR ValueSet Resource, $validate-code operation

4.8.5 Query Value Set

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service to query for Value Sets. A typical example would be to request the set of Value Sets defined by WHO.

Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

1. Query ValueSets: What Value Sets have a publisher name that contains 'WHO'?

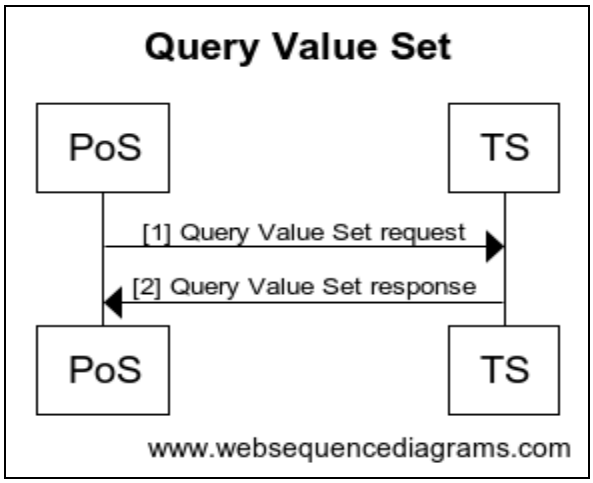
Workflow Maturity	 Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards	The FHIR Value Sets and supported search parameters are defined in: https://www.hl7.org/fhir/valueset.html. Searching in FHIR is described in https://www.hl7.org/fhir/search.html. HL7 FHIR Specifications v3.0 or higher support *Value Set*. The response is a Bundle of Value Set Resources satisfying the search parameters. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Query Value Set ITI-Y1.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

Assumptions and Prerequisites	The required ValueSets have been preloaded into the Terminology Service.
Actors	• PoS - The point-of-service system or other HIE component that is that is querying for Value Sets. • TS - Stores the curated, official version of the Value Sets for the health system.

4.8.5.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	Query Value Set request	The Value Set search request is triggered by a PoS or other HIE component. Input: A set of FHIR search parameters.	FHIR ValueSet Resource
2	Query Value Set response	The response is sent back to the requesting system. Output: a Bundle of ValueSet Resources that satisfy the search parameters.	FHIR ValueSet Resource

4.8.6 Query Code Systems

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service to query for Code Systems. A typical example would be to request the set of Code Systems defined by HL7.

Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

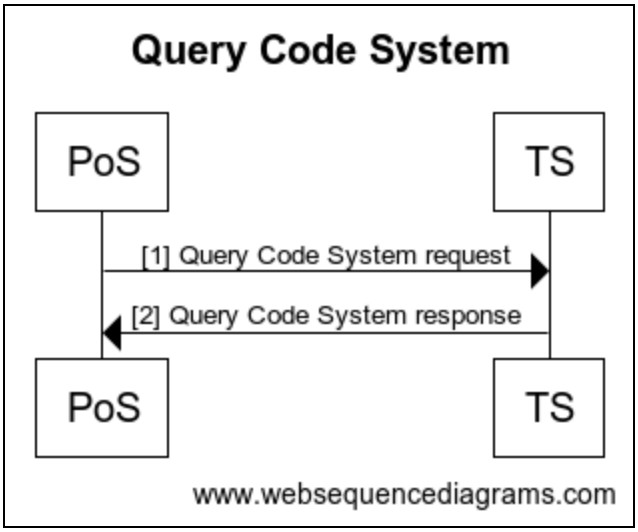
1. Query Code Systems: What Code Systems have a publisher name that contains 'HL7'?

Workflow Maturity	 Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards	The FHIR Code Systems and supported search parameters are defined in: https://www.hl7.org/fhir/codesystem.html. Searching in FHIR is described in https://www.hl7.org/fhir/search.html. HL7 FHIR Specifications v3.0 or higher support Code Systems. The response is a Bundle of CodeSystem Resources satisfying the search parameters. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Query Code System ITI-Y2.	
Assumptions and Prerequisites	The required Code Systems have been preloaded into the Terminology Service.	
Actors	• PoS - The point-of-service system or other HIE component that is that is querying for Code Systems. • TS - Stores the curated, official version of the Code Systems for the health system.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.8.6.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	Query Code System request	The Code System search request is triggered by a PoS or other HIE component. Input: A set of FHIR search parameters.	FHIR CodeSystem Resource
2	Query Code System response	The response is sent back to the requesting system. Output: a Bundle of CodeSystem Resources that satisfy the search parameters.	FHIR CodeSystem Resource

4.8.7 Query Concept Maps

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service to query for Concept Maps. A typical example would be to request the set of Concept Maps whose target Code System is SNOMED CT. Mapping is frequently required when patient data is collected using Concepts/Codes from one Code System but the data must be reported or aggregated, say for decision support, in a different Code System. The set of such associated Concepts,

usually for a specific use-case, are stored in the Terminology Service in a FHIR Resource called a ConceptMap.

Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

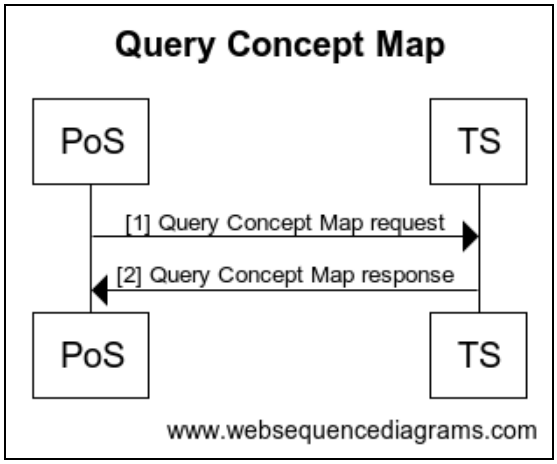
1. Query Concept Maps: What Concept Maps have a map target of 'SNOMED CT''?

Workflow Maturity	 Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards*	The FHIR Concept Maps and supported search parameters are defined in: https://www.hl7.org/fhir/conceptmap.html. Searching in FHIR is described in https://www.hl7.org/fhir/search.html. HL7 FHIR Specifications v3.0 or higher support Concept Maps although Concept Map specifications are not yet normative. The response is a Bundle of Concept Map Resources satisfying the search parameters. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Query Concept Map ITI-Y6.	
Assumptions and Prerequisites	The required Concept Maps have been preloaded into the Terminology Service.	
Actors	• PoS - The point-of-service system or other HIE component that is that is querying for Concept Maps. • TS - Stores the curated, official version of the Concept Maps for the health system.	

**For information about IHE Standard Maturity, see the standard (see section 4.1)*

4.8.7.1 Interaction Description

The following is a description of the interaction steps.



#	Interaction	Data	Transaction Options
1	Query Concept Map request	The Concept Map search request is triggered by a PoS or other HIE component. Input: A set of FHIR search parameters.	FHIR ConceptMap Resource
2	Query Concept Map response	The response is sent back to the requesting system. Output: a Bundle of ConceptMap Resources that satisfy the search parameters.	FHIR ConceptMap Resource

4.8.8 Lookup Code

This transaction allows a PoS, or any OHIE component, to access terminological information in the terminology service to retrieve detailed information on a code. A typical example would be to retrieve descriptive information on a laboratory code from the LOINC Code System.

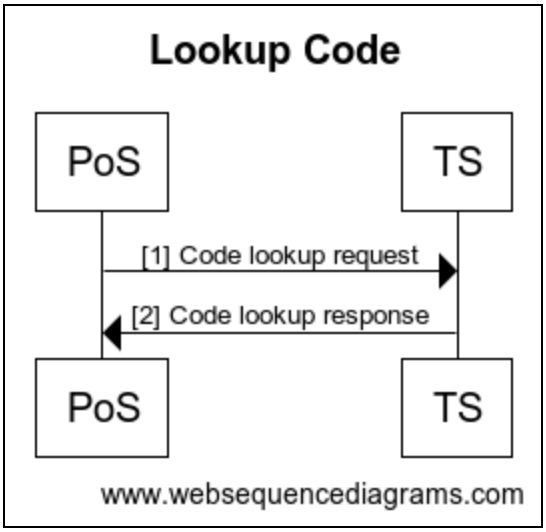
Both external systems and systems inside the HIE may perform this transaction directly with the TS. The sequence diagram below shows the steps that occur for a system using this transaction.

1. Lookup: Retrieve information on Code '26453-1' in the LOINC Code System.

Workflow Maturity	Mature	• One or more OpenHIE implementations of this workflow exist in one or more countries • Workflow is defined and ARB approved • Workflow is supported by mature standards
Standards*	The FHIR CodeSystem *lookup* operation: https://www.hl7.org/fhir/codesystem-operation-lookup.html. HL7 FHIR Specifications v3.0 or higher support *lookup*. The response is an object that contains details about the code, including definition, status, designations, and properties. This workflow implements the IHE IT Infrastructure Technical Framework Supplement - Sharing Valuesets, Codes, and Maps (SVCM) Transaction: Lookup Code ITI-Y4.	
Assumptions and Prerequisites	The required CodeSystems have been preloaded into the Terminology Service and the specified code exists in the Code System.	
Actors	• PoS - The point-of-service system or other HIE component that is requesting to lookup a code. • TS - Stores the curated official version of the terminology and codes for the health system.	

4.8.8.1 Interaction Description

The following is a description of the interaction steps.



For information about IHE Standard Maturity, see the standard (see section 4.1)

Ref	Interaction	Data	Transaction Options
1	Code Lookup request	The validate-code request is triggered by a PoS or other HIE component. Input: A Concept Code and target Code System.	FHIR CodeSystem Resource, $lookup operation
2	Code Lookup response	The response is sent back to the requesting system. Output: an object containing code information.	FHIR CodeSystem Resource, $lookup operation