

# Interoperability Land™

## Event Guide

**Version 1 | January 2020**

This guide is targeted at Developers for the Blue Cross Blue Shield of Michigan  
Connectathon



# Table of Contents

Overview .....	3
Interoperability Land™ .....	3
Terminology .....	4
Quick Links.....	4
Introduction to FHIR .....	5
Fast Healthcare Interoperability Resources (FHIR) .....	5
Why FHIR Is Important.....	5
How FHIR Works and Understanding FHIR Resources .....	5
Other FHIR Initiatives .....	5
HEDIS/Stars Introduction.....	6
Getting Started with IOL.....	6
Getting Access .....	6
Logging In .....	6
Exploring the Homepage & Site Navigation.....	8
Homepage .....	8
Navigation Menu.....	8
Settings and Help Menu.....	8
Dashboard .....	8
Exploring the Sandbox.....	9
Accessing your Sandbox.....	9
Sandbox Tab Menu .....	9
Exploring the PITs .....	9
InterOp PIT Tiles.....	9
PIT Tab Menu .....	9
Connecting a SMART on FHIR App .....	10
Completing a Query .....	13
Accessing the PIT and HAPI FHIR API .....	13
Navigating the Resources .....	13

## Interoperability Land Event Guide

Performing a Basic Query .....	14
Performing an Advanced Query .....	15
CDex HEDIS/Stars.....	16
Scenario 1-Determine eligibility of patient for HEDIS TRC eligibility criteria .....	16
Queries for Scenario 1- Using the HAPI FHIR Interface .....	18
Scenario 2- Calculating total patients in a health system who meet HEDIS TRC eligibility criteria.....	27
Queries for Scenario 2- Using the HAPI FHIR Interface .....	28
Rest Client Guide.....	32
Appendix.....	34
Querying FHIR Resources: A Supplementary Guide to the Event Guide .....	34
Data linkage.....	37
Crafting more complex queries to answer questions.....	39
Limitations to out-of-the-box queries.....	39
Workarounds to these limitations .....	40

# Overview

## Interoperability Land™

Interoperability Land is a cloud-hosted digital collaboration platform designed to power the future of multi-organization development, integration, acceptance, and testing of innovative technologies and open standards. Organizations can learn, build and test healthcare applications and services with no risk of PHI disclosure using highly realistic, clinically relevant, synthetic patient data.

Two types of synthetic data are available in IOL:

- **PatientGen™** is an HL7 FHIR-compatible test data generator that models a simulated healthcare network of providers, practices, and hospitals with a large population of patients who experience changes in their health status and mortality risks for many important medical conditions and procedures.
- **Personas** are realistic and complete synthetic representations of a person. Personas have unique attitudes, conditions, and environments that affect how they interact with each other and the healthcare system.

Both are designed to showcase new technology, promote standards (e.g. HL7 FHIR®), and accelerate interoperability.

This synthetic ecosystem allows healthcare organizations to:

- Demonstrate apps and services in an engaging and meaningful way using data visualization to reveal interoperability between systems
- Rigorously test and certify that applications meet standards, performance and scalability requirements
- Collaborate with other organizations to develop and test interoperable, standards-compliant solutions
- Host collaborative events to promote learning and standards-based technology adoption
- Deliver higher quality applications and services faster to market

## Terminology

**InterOp PIT:** Pilot Interoperability Testbed, a Fast Healthcare Interoperability Resources (FHIR®) server that represents a real-world healthcare organization, populated with synthetic patient data.

**Patient-Gen™:** A synthetic patient data generator.

**Persona:** A hand-made synthetic patient, custom fitted to align with various use-cases.

**IOL Ring:** A grouping of various servers that includes EHRs, Pharmacies, Payers, and an HIE, populated with synthetic data that is choreographed across each to emulate a real-world healthcare ecosystem.

**HL7 FHIR:** Health Level Seven's Fast Healthcare Interoperability Resources

**Resource:** Any data file containing synthetic patient data. Formatted in JSON.

**Sandbox:** The development environment that contains all PITs and IOL Ring

**HAPI FHIR®:** A user interface (UI) that assists in interacting with a FHIR server through querying and displaying FHIR data.

## Quick Links

**HL7 FHIR Website:** <https://www.hl7.org/fhir/>

**Da Vinci Use Cases:**

<https://confluence.hl7.org/display/DVP/Da+Vinci+Implementation+Guide+Dashboard>

**Connectathon GitHub:** <https://github.com/courtney-delgoffe/BCBSM-Connectathon-2020>

# Introduction to FHIR

## Fast Healthcare Interoperability Resources (FHIR)

Health Level Seven International (HL7), a not-for-profit organization that develops and standardizes data framework for the exchange of electronic health information, has developed a specification standard known as Fast Healthcare Interoperability Resources (FHIR).

### Why FHIR Is Important

FHIR is designed to help health information organizations more quickly and easily exchange and retrieve data from electronic health record (EHR) systems, and to help health IT developers more efficiently build applications to support this exchange of information.

### How FHIR Works and Understanding FHIR Resources

FHIR frameworks are built around the concept of “resources” – these objects are basic, modular units of interoperability that can be assembled into working systems to try to resolve clinical, administrative and infrastructural problems in healthcare.

Administrative concepts such as patients, providers, organizations and devices, as well as a variety of clinical concepts including conditions, medications, diagnostics, care plans and claims information, among others are translated into FHIR resources with structured and standardized data for easy interoperability between EHR vendors and other software development resources and tools.

FHIR is designed specifically for the web and provides resources and foundations in two formats XML and JSON.

More information on FHIR can be found at: <https://www.hl7.org/fhir/overview.html>

### Other FHIR Initiatives

SMART on FHIR has also gained broad industry support. The SMART on FHIR initiative is based at Boston Children’s Hospital and features a set of open specifications to integrate apps with EHRs, portals, health information exchanges and other health IT systems.

Another initiative is HAPI FHIR (“happy fire”), an open source Java implementation of the FHIR specification. It was developed at University Health Network in Ontario, Canada. HAPI FHIR is free to use.



## HEDIS/Stars Introduction

Clinical Data Exchange (CDex) is looking to improve exchange methods between providers, payers, and other systems to make exchange of health record information more efficient and effective. In turn, allowing improved care coordination, network performance, delivery of patient care and outcomes, and reducing the burden of quality reporting.

Payers use clinical information gathered from providers to support the HEDIS/Stars quality program. The Healthcare Effectiveness Data and Information Set (HEDIS) is made up of standardized performance measures to assess value of care and hold health plans accountable for their performance.

For more information on HEDIS please see the

## Getting Started with IOL

### Getting Access


Participants in an event will receive a temporary login sent to the email address used to register for the event. Click the link in the email, or open your internet browser and enter the following URL: <https://www.interopland.com/login>

### Logging In

Log into Interoperability Land using the provided temporary credentials. Upon logging in you will be prompted to enter a new password and accept the terms and conditions.



## Interoperability Land Event Guide



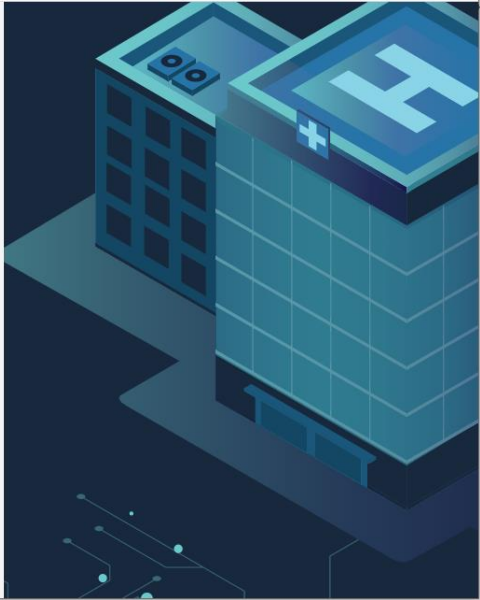
**Sign in**  
Welcome to Interoperability Land™

USERNAME

PASSWORD

[Forgot your password?](#)

**Sign in**





## Exploring the Homepage & Site Navigation

### Homepage

The image below serves as the home page for IOL and can be accessed at any time by clicking the Interoperability Land logo in the top-left corner of your browser.

### Navigation Menu

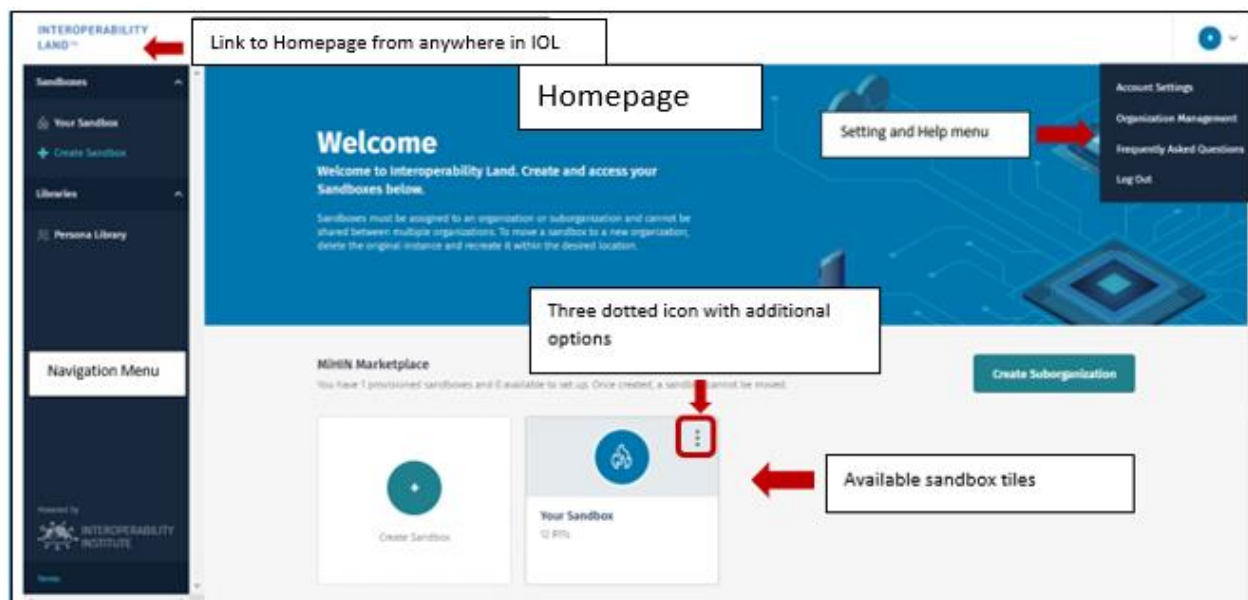
On the left-hand side of the browser you will see the navigation menu. This menu contains links to all **Sandboxes** and the **Persona library** you have access to.

### Settings and Help Menu

In the top-right corner of the browser, you will see your profile icon. Clicking this opens a drop-down menu containing **Account Settings**, **Organization Management**, **Frequently Asked Questions**, and **Log Out**.

### Dashboard

In the main section of the dashboard you can find your organizations, sub-organizations, and Sandboxes. The tiles on your homepage include a three-dotted icon with additional options.



## Exploring the Sandbox

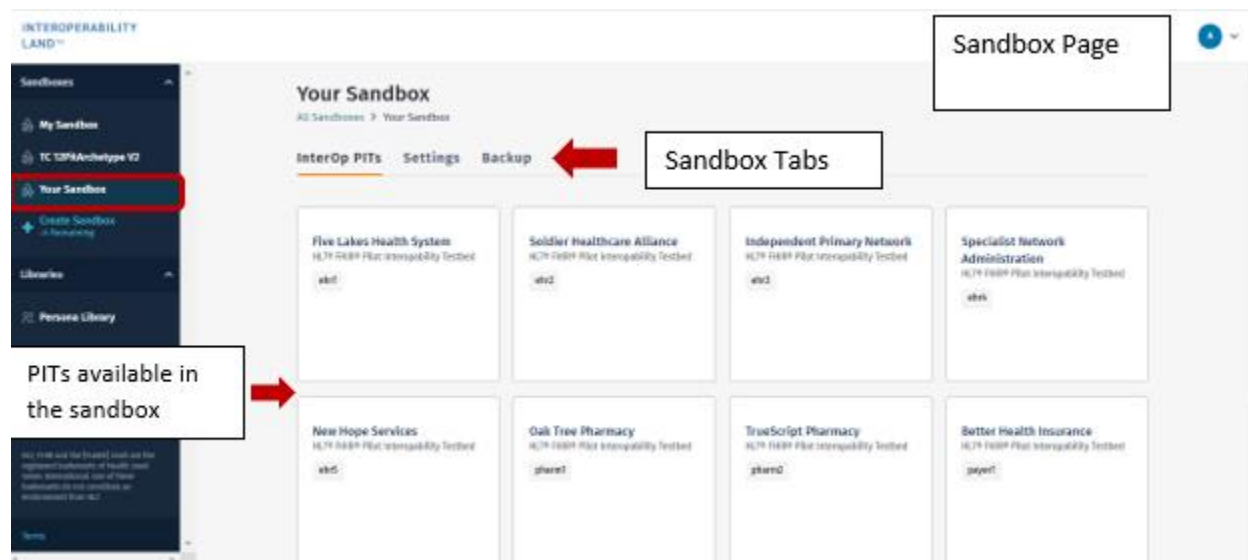
### Accessing your Sandbox

You can access your sandbox by clicking either the tile on the homepage or the link in the navigation menu side-bar.

### Sandbox Tab Menu

The tab menu at the top allows you to cycle through the Interop PITs display, Sandbox Settings, and Sandbox Backup. In the settings tab, you may delete your Sandbox. In the Backup tab, you can create up to **2** backups of your Sandbox or **Reset to Initial State**.

**Note:** Resetting to initial state does **not** clear your backups.



## Exploring the PITs

### InterOp PIT Tiles

Each tile under the InterOp PITs tab contains basic information about the PIT and is also a button to access its details menu. Simply click a tile to access more details about the PIT.

### PIT Tab Menu

The Tab menu under the PIT contains the Overview, Capabilities Statement, SMART Apps, and Visualizations. The overview contains a link to access the PIT, along with the PIT's username, password, and authentication credentials.



## Interoperability Land Event Guide

### Five Lakes Health System

All Sandboxes > Your Sandbox > Five Lakes Health System

**Overview** Capabilities Statement SMART Apps Visualizations

#### Five Lakes Health System

Link	<a href="https://org-96-td2se.devinteroplnd.com/five-lakes-health-system/">https://org-96-td2se.devinteroplnd.com/five-lakes-health-system/</a>	Copy
Username	interop_fhir_pit	Copy
Password	*****	Reveal Copy
Basic Authentication Credentials	*****	Reveal Copy

## Connecting a SMART on FHIR App

Select the PIT you would like to connect to the SMART of FHIR App.

### Your Sandbox

All Sandboxes Your Sandbox

**FHIR PITs** Settings Backup

**Five Lakes Health System**  
ehv1  
<https://mihin-sandy.devinteroplnd.com/five-lakes-health-system/>

**Soldier Healthcare Alliance**  
ehv2  
<https://mihin-sandy.devinteroplnd.com/soldier-healthcare-alliance/>

**Independent Primary Network**  
ehv3  
<https://mihin-sandy.devinteroplnd.com/independent-primary-network/>

Click the SMART Apps tab within the PIT. Then click Register a New App.

**Sandboxes**

- test2
- QA SarahTrudy02
- Zane QA Test 1
- SMART DEMO TEST RING (STU3)
- Your Sandbox**
- Create Sandbox
- Libraries
  - Persona Library

### Five Lakes Health System

All Sandboxes Your Sandbox Five Lakes Health System

**Overview** Capabilities Statement **SMART Apps** Visualizations

There are currently no SMART apps registered with this FHIR PIT

Registering an app will allow you to connect using the SMART on FHIR launch sequence.

[Register a New App](#)

## Interoperability Land Event Guide

Enter a name for the app along with the redirect URL.

Register Smart App

×

Register your SMART app to gain access to Five Lakes Health System.

NAME \*

Symbols other than +, -, @, - are not permitted.

SMART APP NAME

REDIRECT URI(S) \*

Add multiple URI(s) by separating addresses with a comma.

https://d2q3p4uhw0bf3v.cloudfront.net/standalone

Cancel

OK

After clicking “OK” the details will appear, including the App Client ID that is used to connect from the App.

SMART APP NAME

All Sandboxes > Your Sandbox > Five Lakes Health System > SMART APP NAME

Delete SMART App

Details

REGISTERED ON

Tue, 06 Oct 2019 18:12:52 GMT

APP CLIENT ID

509ds1bar06sj0antf5dc7lh3

REDIRECT URI

https://d2q3p4uhw0bf3v.cloudfront.net/standalone

SMART App Launchers

Create New Launcher

There are currently No SMART App Launchers. Creating a SMART App Launcher will allow you to launch a SMART App from Interoperability Land.

Enter the App client ID on the **app side**. Example:

Specify information for the SMART on FHIR server to launch against

FHIR server:

Client ID:

509ds1bar06sj0antf5dc7lh3

Secret (if needed):

Note: Specify https://d2q3p4uhw0bf3v.cloudfront.net/standalone as the redirect URL on the SMART on FHIR server.

Note: The information you enter above is stored in your local browser state to make it available across uses.

Connect

## Interoperability Land Event Guide

Navigate to the PIT via the breadcrumb or the Sandbox link in the Navigation Menu.

The screenshot shows the 'SMART APP NAME' page. At the top, there is a breadcrumb trail: 'All Sandboxes > Your Sandbox > Five Lakes Health System'. The 'Five Lakes Health System' link is highlighted with a red box. To the right of the breadcrumb is a red button labeled 'Delete SMART App'. Below the breadcrumb is a section titled 'Details' containing a table with the following information:

REGISTERED ON	APP CLIENT ID
Tue, 08 Oct 2019 16:12:52 GMT	504d51b4b1b5c0e0f6c7013
REDIRECT URI	
<a href="https://d2q3pauweb0bf3x.cloudfront.net/standalone">https://d2q3pauweb0bf3x.cloudfront.net/standalone</a>	

Below the table is a section titled 'SMART App Launchers' with a green button labeled 'Create New Launcher'. At the bottom, there is a message: 'There are currently No SMART App Launchers. Creating a SMART App Launcher will allow you to launch a SMART App from Interoperability Land.'

Copy the URL address link on the PIT's Overview tab.

The screenshot shows the 'Five Lakes Health System' Overview page. At the top, there is a breadcrumb trail: 'All Sandboxes > Your Sandbox > Five Lakes Health System'. Below the breadcrumb is a navigation bar with four tabs: 'Overview', 'Capabilities Statement', 'SMART Apps', and 'Visualizations'. The 'Overview' tab is selected. Below the navigation bar is a section titled 'Five Lakes Health System' with a warning message: 'This is not a production server. Do not store any personal health or other confidential information here.' Below the warning message is a section titled 'Link' with the URL: <https://mihin-sandy.devinteroplant.com/five-lakes-health-system/>. To the right of the URL is a red button labeled 'Copy'. Below the URL is a section titled 'Username' with the text: 'interop\_fhmr\_pit'. To the right of the text is a green button labeled 'Copy'. Below the username is a section titled 'Password' with a masked password: '\*\*\*\*\*'. To the right of the password are two buttons: 'Reveal' and 'Copy'.

## Interoperability Land Event Guide

Paste the URL address as the FHIR Server address on the app side, then add **/fhir** at the end of the URL. Example: <https://organization.interopland.com/five-lakes-health-system/fhir>



Specify information for the SMART on FHIR server to launch against

FHIR server:

Client ID:

Secret (if needed):

Note: Specify <https://d1q3p4uhubf3v.cloudfront.net/standalone> as the redirect URL on the SMART on FHIR server.

Note: The information you enter above is stored in your local browser state to make it available across uses.

Select “Connect” and your SMART on FHIR App will launch.

## Completing a Query

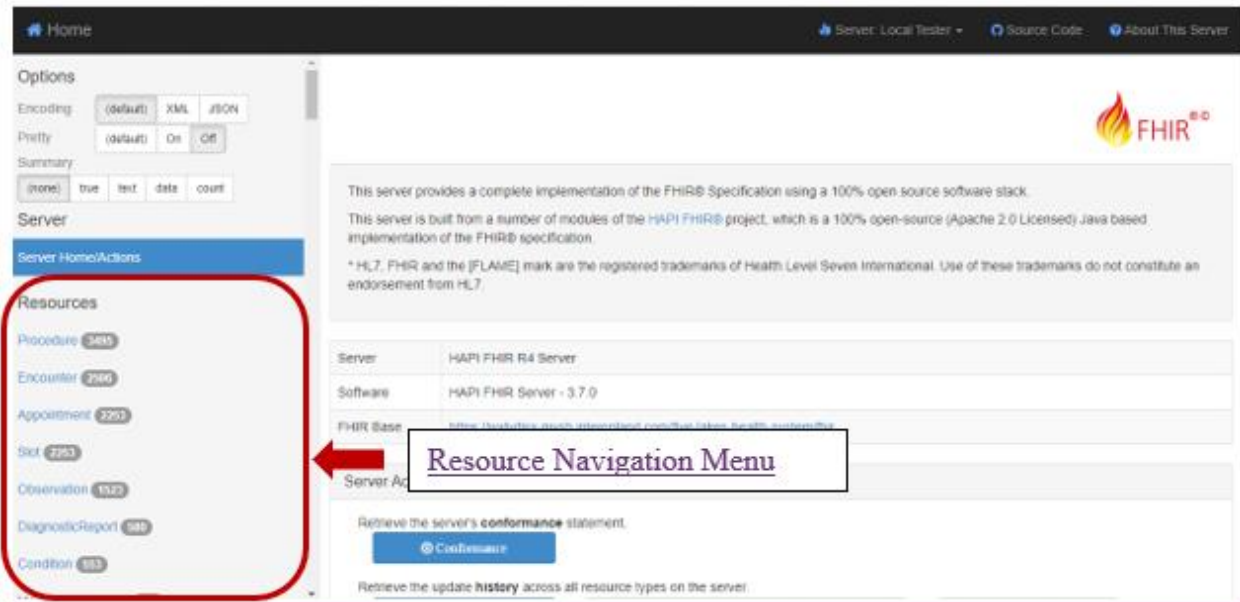
### Accessing the PIT and HAPI FHIR API

Follow the link located under the Overview tab within the PIT you are trying to query. This will access the HAPI FHIR API’s user interface.

## Navigating the Resources

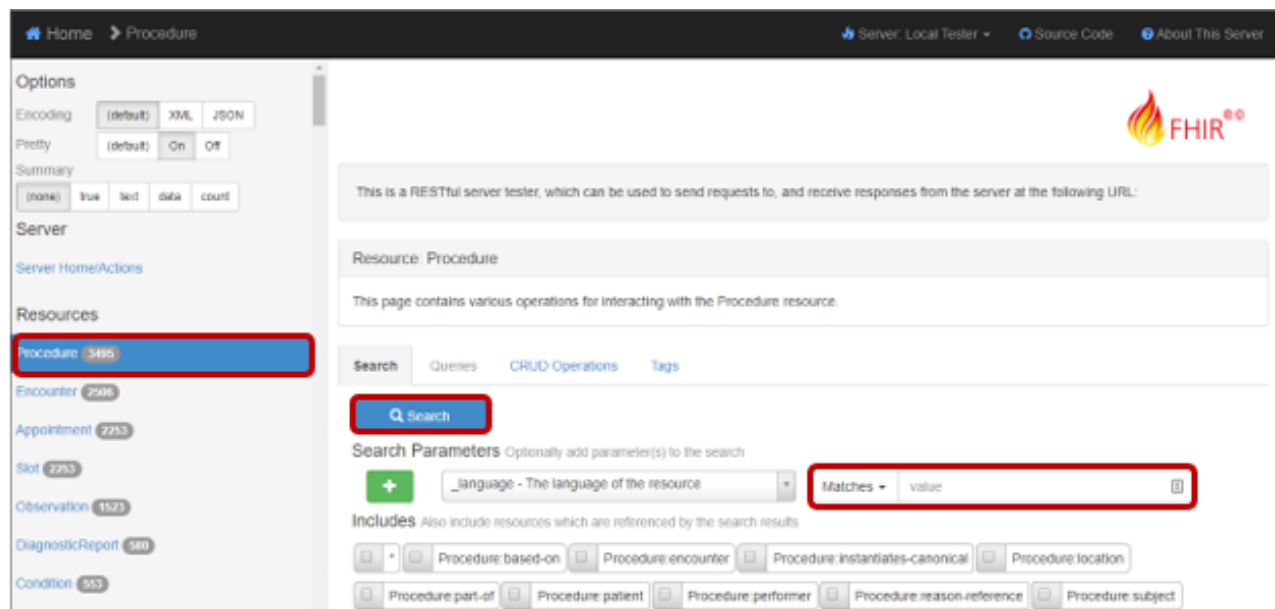
The FHIR Resources are displayed in the left-hand navigation menu alongside the number of instances of each resource.

## Interoperability Land Event Guide



## Performing a Basic Query

Find the type of resource you would like to query in the resource navigation menu and select it. A search tool will appear with several options to modify your query. To perform a basic query and pull every resource of the type you selected, leave the values at default/blank then click “search.”



Within the result body section, you will find a GET URL, Response data, and a JSON bundle in both individual files and raw bundle formats (see screenshots below).

## Interoperability Land Event Guide

**Request**  
**Request Headers**

GET https://wxlydjsx-mysb.interopland.com/five-lakes-health-system/fhir/Procedure?\_pretty=true

Get URL

Accept-Charset: utf-8  
Authorization: Basic aW50ZXJvcF9waXQ6a1R4OThtUHQpCj9wamx0V0ZBN1o1N3NlV10wFZBeUZieTlF  
Accept: application/fhir+xml;q=1.0, application/fhir+json;q=1.0, application/xml+fhir;q=0.9, application/json+fhir;q=0.9  
User-Agent: HAPI-FHIR/3.7.0 (FHIR Client; FHIR 4.0.0/R4; apache)  
Accept-Encoding: gzip

**Response**  
**Response Headers**

✓ HTTP 200

date: Thu, 16 Jan 2020 19:22:05 GMT  
access-control-allow-origin: \*  
last-modified: Thu, 16 Jan 2020 19:22:04 GMT  
transfer-encoding: chunked  
access-control-allow-headers: Origin, Content-Type, X-Auth-Token, Authorization  
x-powered-by: HAPI FHIR 3.7.0 REST Server (FHIR Server; FHIR 4.0.0/R4)  
content-type: application/fhir+json;charset=utf-8  
connection: keep-alive  
access-control-allow-methods: GET, POST, PATCH, PUT, DELETE, OPTIONS

Response Data

**Result Body**  
JSON bundle  
(47767 bytes)

JSON Bundle

Bundle contains 20 entries

Prev Page

Next Page

	ID	Updated
<a href="#">Read</a> <a href="#">Update</a>	Procedure/36/_history/1	2019-08-16 21:00:45
<a href="#">Read</a> <a href="#">Update</a>	Procedure/37/_history/1	2019-08-16 21:00:45
<a href="#">Read</a> <a href="#">Update</a>	Procedure/43/_history/1	2019-08-16 21:00:51
<a href="#">Read</a> <a href="#">Update</a>	Procedure/44/_history/1	2019-08-16 21:00:51
<a href="#">Read</a> <a href="#">Update</a>	Procedure/50/_history/1	2019-08-16 21:01:12
<a href="#">Read</a> <a href="#">Update</a>	Procedure/51/_history/1	2019-08-16 21:01:12

### Raw Message

```
{
  "resourceType": "Bundle",
  "id": "18ad3996-af5a-4301-9a99-f9b6b47c91a4",
  "meta": {
    "lastUpdated": "2020-01-16T19:22:04.884+00:00"
  },
  "type": "searchset",
  "link": [
    {
      "relation": "self",
      "url": "https://wxlydjsx-mysb.interopland.com/five-lakes-health-system/fhir/Procedure?_pretty=true"
    },
    {
      "relation": "next",
      "url": "https://wxlydjsx-mysb.interopland.com/five-lakes-health-system/fhir?_getpages=18ad3996-af5a-4301-9a99-f9b6b47c91a4&_getpagesoffset=20&_count=20&_pretty=true&_bundleType=searchset"
    }
  ],
  "entry": [
    {
      "fullUrl": "https://wxlydjsx-mysb.interopland.com/five-lakes-health-system/fhir/Procedure/36",
      "resource": {
        "resourceType": "Procedure",
        "id": "36",
        "meta": {
          "versionId": "1",
          "lastUpdated": "2019-08-16T21:00:45.000+00:00"
        },
        "extension": [

```

## Performing an Advanced Query

In the resource's search tool, click the drop-down next to the green plus button to select a datapoint within the resource to query. Then enter a value to query. The server will return the same data type as before: GET URL, Response data, and a JSON bundle in both individual files and raw bundle formats.



## Interoperability Land Event Guide

Searches for a patient can be done with at least one identifying piece of information such as name, social security number or patient ID.

**Example:** Click the **Patient** resource, then switch the search parameter to **name**, and enter the value **Sarah**. Click search.



This results in a bundle of Patient resources that all contain Sarah within the name value array (as highlighted in screen shot below).

<b>Result Body</b> JSON bundle (18376 bytes)	Bundle contains 4 / 4 entries		
	ID		Updated
	 	Patient/154/_history/1	2019-08-16 21:06:11
	 	Patient/2394/_history/1	2019-08-16 21:59:16
	 	Patient/13644/_history/1	2019-08-17 02:47:52
	 	Patient/SarahThompson/_history/1	2019-12-12 15:48:30

## CDex HEDIS/Stars

### Scenario 1-Determine eligibility of patient for HEDIS TRC eligibility criteria

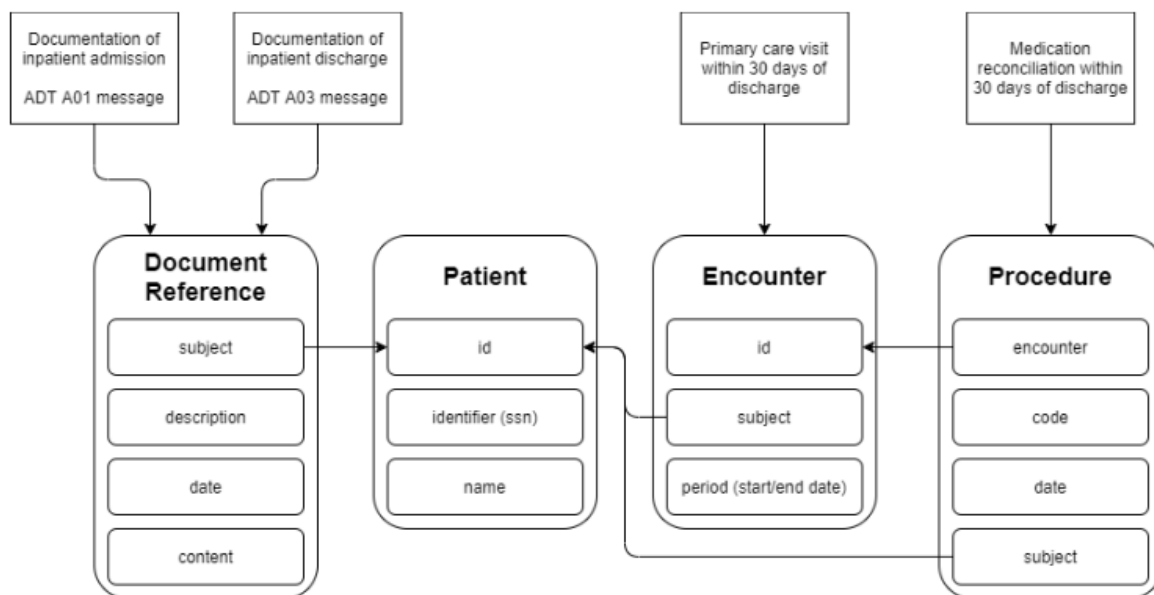
Unlock ways to identify if a patient meets the HEDIS TRC measure by leveraging FHIR resource data via query.

HEDIS TRC – Transitions of Care measure requires four data points- for this Connectathon we will use these documents to query for data needed to identify if the patients meet the HEDIS Stars measure:



## Interoperability Land Event Guide

1. Documentation of receipt of inpatient admission
  - Documentation of receipt of inpatient admission is represented using a FHIR **DocumentReference** resource containing an ADT A01 message
2. Documentation of receipt of discharge information
  - FHIR **DocumentReference** resource containing an ADT A03 message
3. Follow-up visit with primary care provider within 30 days of discharge
  - Follow-up visit with primary care provider within 30 days of discharge is represented using a FHIR **Encounter** Resource
4. Medication reconciliation within 30 days of discharge
  - Documented as a **Procedure** resource with a Snomed code for Medication Reconciliation procedure: 430193006



## Queries for Scenario 1- Using the HAPI FHIR Interface

### Query 1 – Finding A Patient By SSN

Because the HAPI FHIR Interface only supports a limited set of search parameters, an additional initial query is necessary to find the Patient record by SSN. The id of the Patient record we find will be used in future queries.

Searching for a patient requires selecting the Patient option from the resource's navigation menu on the left side of the page. Specifying the SSN to search for is then accomplished by selecting the identifier option in the search parameters dropdown, then entering the target SSN in the code field to the right (as seen below SSN 000003044 is used in this example).

The screenshot shows the HAPI FHIR interface. On the left, a navigation menu lists resources: DiagnosticReport (424), Patient (343), AllergyIntolerance (294), Practitioner (218), MedicationStatement (140), and Schedule (77). The 'Patient' resource is selected. On the right, the 'Search' tab is active. The 'Search Parameters' dropdown is set to 'identifier - A patient identifier'. The 'Matches' dropdown is set to 'System (op)'. The 'Code' field contains '000003044'.

This query produces the result shown below. Pay particular attention to the lower-right area of the screen, which contains the section labelled Result Body. This is the data returned in response to the query.

The screenshot shows the HAPI FHIR interface displaying the response details. The 'Request' section shows the GET request to the HAPI FHIR endpoint. The 'Response' section shows the HTTP 200 status and response headers. The 'Result Body' section, highlighted with a red box, shows a JSON bundle containing 1 entry. The entry is a Patient resource with ID 'Patient/1754/\_history/1' and an updated timestamp of '2020-01-10 20:48:13'. Below the Result Body, the 'Raw Message' section shows the raw JSON response.

ID	Updated
<a href="#">Read</a> <a href="#">Update</a> Patient/1754/_history/1	2020-01-10 20:48:13

```

{
  "resourceType": "bundle",
  "id": "817f3004-1b65-4da5-bde4-77fa655879fb",
  "meta": {
    "lastUpdated": "2020-01-17T16:04:45.788+00:00"
  },
  "type": "searchset",
  "links": [
    {
      "relation": "self",
      "url": "https://wxdydx-bcbsm.interopland.com/five-lakes-health-system/fhir/Patient?_pretty=true&identifier=000003044"
    }
  ]
}
    
```

## Interoperability Land Event Guide

The Result Body section in this case contains a line at the top that reads “Bundle contains 1 / 1 entries”. This line shows how many results matched the query that was specified; the first number is the count of results included in this response, the second is the total number of records satisfying that query in this PIT. When a query matches a large number of records, the numbers can be different because the FHIR server has a limit on the number of records it can return in a single response.

Below the summary section is a section labelled Raw Message. This section contains the actual data sought by the query (in this case, a Patient record identified by the supplied SSN).

```
Raw Message

{
  "resourceType": "Bundle",
  "id": "037f3004-19e5-4da9-8de4-77f8855873fb",
  "meta": {
    "lastUpdated": "2020-01-17T16:04:45.700+00:00"
  },
  "type": "searchset",
  "total": 1,
  "link": [
    {
      "relation": "self",
      "url": "https://wxiydjx-bcbsm.interoplnd.com/five-lakes-health-system/fhir/Patient?pretty=true&identifier=000003044"
    }
  ],
  "entry": [
    {
      "fullurl": "https://wxiydjx-bcbsm.interoplnd.com/five-lakes-health-system/fhir/Patient/1754",
      "resource": {
        "id": "1754",
        "versionId": "1",
        "lastUpdated": "2020-01-10T20:40:13.000+00:00",
        "text": {
          "status": "generated",
          "div": "<div xmlns='http://www.w3.org/1999/xhtml'>This is a simple example with only plain text</div>"
        },
        "extension": [
          {
            "url": "http://mihin.org/extension/copyright",
            "valueString": "Copyright 2014-2019 Michigan Health Information Network Shared Services. Licensed under the Apache License, Version 2.0 (the 'License'); you may not use this file except in compliance with the license. You may obtain a copy of the license at http://www.apache.org/licenses/LICENSE-2.0. Unless required by applicable law or agreed to in writing, software distributed under the license is distributed on an 'AS IS' BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied. See the license for the specific language governing permissions and limitations under the license."
          },
          {
            "url": "http://hl7.org/fhir/us/core/StructureDefinition/us-core-race",
            "valueCodeableConcept": {
              "coding": [
                {
                  "system": "http://hl7.org/fhir/v3/Race",
                  "code": "2186-3",
                  "display": "White"
                }
              ]
            }
          },
          {
            "url": "http://hl7.org/fhir/us/core/StructureDefinition/us-core-ethnicity",
            "valueCodeableConcept": {
              "coding": [
            
```

There is a wealth of information about the patient here, but the main field of interest for purposes of this exercise is the id. Specified under the “resource” element of a member of the “entry” collection, this is the unique identifier of this particular patient record within the PIT. It is what other records will use to refer to this patient and thus can be used to search for only records relevant to this patient.

```
"entry": [  
  {  
    "fullUrl": "https://wxlydjsx-bcbsm.interopland.com/five-lakes-health-system/fhir/Patient/1754",  
    "resource": {  
      "resourceType": "Patient",  
      "id": "1754",  
      "meta": {  
        "versionId": "1",  
        "lastUpdated": "2020-01-10T20:48:13.000+00:00"  
      }  
    }  
  }  
]
```

### Query 2 – Finding Admission Documents By Patient

An admission record is represented in this PIT by a DocumentReference object containing an ADT A01 message. To locate only the admission documents relevant to a specific patient, two search parameters are necessary. First, the patient is specified by choosing the subject option from the search parameter dropdown, then entering the id from the previous query's result in the Resource ID field. A second search parameter can be added by clicking the green button with a white plus sign. This second parameter should be used to specify the type of document by selecting the description option from the search parameter dropdown, then entering A01 in the value field. See below for an example.

The screenshot shows the HAPI FHIR interface. On the left, a sidebar lists resource types: DocumentReference (5875), Encounter (5231), Appointment (4088), Slot (4356), and Observation (3963). The 'DocumentReference' resource is selected and highlighted with a red box. The main area has tabs for Search, Queries, CRUD Operations, and Tags. The 'Search' tab is active. Below the tabs is a search bar with a magnifying glass icon and the text 'Search'. Below the search bar is a section titled 'Search Parameters' with the subtitle 'Optionally add parameter(s) to the search'. There are two search parameters defined: 'subject - Who/what is the subject of the document' with a value of '1754', and 'description - Human-readable description' with a value of 'A01'. Both parameter fields are highlighted with red boxes. A green plus button is located to the left of the search parameters section.

This produces a result in the standard form for the HAPI FHIR interface.

# Interoperability Land Event Guide

**Result Body**

JSON bundle  
(5379 bytes)

ID	Updated
<a href="#">Read</a> <a href="#">Update</a> DocumentReference/20400/_history/1	2020-01-10 22:33:59

**Raw Message**

```
{
  "resourceType": "Bundle",
  "id": "0929db49-79eb-48ae-92d9-0308d3f46566",
  "lastUpdated": "2020-01-17T16:43:40.353+00:00",
  "type": "searchset",
  "total": 1,
  "link": [
    {
      "relation": "self",
      "url": "https://wxyldjxs-bcbsm.interopland.com/five-lakes-health-system/fhir/DocumentReference?pretty=true&description=A01&subject=1754"
    }
  ],
  "entry": [
    {
      "fullUrl": "https://wxyldjxs-bcbsm.interopland.com/five-lakes-health-system/fhir/DocumentReference/20400",
      "resource": {
        "resourceType": "DocumentReference",
        "id": "20400",
        "meta": {
          "versionId": "1",
          "lastUpdated": "2020-01-10T22:33:59.000+00:00"
        },
        "text": {
          "status": "generated",
          "div": "<div xmlns='http://www.w3.org/1999/xhtml'>This is a simple example with only plain text</div>"
        },
        "extension": [
          {
            "url": "http://hl7.org/fhir/extension/copyright",
            "valueString": "Copyright 2014-2019 Michigan Health Information Network Shared Services. Licensed under the Apache License, Version 2.0 (the 'License'); you may not use this file except in compliance with the License. You may obtain a copy of the license at http://www.apache.org/licenses/LICENSE-2.0. Unless required by applicable law or agreed to in writing, software distributed under the license is distributed on an 'AS IS' BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied. See the license for the specific language governing permissions and limitations under the license."
          }
        ],
        "masterIdentifier": {
          "use": "official",
          "value": "03dd2a09-f165-4277-9846-6e153f3fe428"
        },
        "identifier": [
          {
            "use": "official",
            "value": "03dd2a09-f165-4277-9846-6e153f3fe428"
          }
        ],
        "status": "current",
        "docStatus": "final",
        "type": "discharge-summary",
        "coding": [
          {
            "system": "http://loinc.org",
            "code": "18842-5",
            "display": "Discharge summary"
          }
        ]
      }
    }
  ]
}
```

**Date the document was added to the PIT**

**Reference to patient**

**Date of admission**

**Encoded original message**

In the returned DocumentReference, several fields of interest can be seen. The “date” field shows the relevant date of the described document (in this case, the date the admission occurred). It should not be confused with the “lastUpdated” field, which indicates when this document was added to the PIT.

Also available here is the “data” field (located under “content” and “attachment”), which contains the encoded original message. The patient being referred to can be confirmed by examining the “subject” field, which in this case contains both the patient’s name and the reference “Patient/1754”, indicating that the subject of this document is a Patient with id 1754.

### Query 3 – Finding Discharge Documents By Patient




Similar to admission records, discharge records are represented by a DocumentReference containing an ADT A03 message. They can be queried in the same fashion as admission records, using the DocumentReference resource with the “subject” and “description” search parameters.



The result has exactly the same structure as the result of the admission record query, since it is querying the same resource.



Raw Message

 Server: Local Tester ▾
  Source Code
  About This Server

Date of Discharge-Day 1 of 30 day window for follow up and medication reconciliation



The date field is once again of primary interest, showing the date of the patient's discharge (and thus establishing the beginning of the 30 day window in which the follow-up visit and MedRec procedure must occur in order to satisfy the HEDIS quality measure).

### Query 4 – Finding Medication Reconciliation Procedures By Patient

When a Medication Reconciliation is performed, it is recorded under the Procedure resource. This resource can be queried using the subject parameter in the same fashion as the DocumentReference resource in the previous two queries. This will restrict the result to only procedures performed on the specified patient. The search results can be further refined by using the code search parameter to retrieve only Medication Reconciliation procedures (based on the Snomed code for that procedure: 430193006).

The screenshot shows the FHIR Search interface. On the left, under 'Resources', 'Procedure' (6215) is selected and highlighted with a red box. In the center, under 'Search Parameters', 'subject - Search by subject' is selected and highlighted with a red box. To the right, the 'subject' field contains the value '1754'. Below it, 'code - A code to identify a procedure' is selected and highlighted with a red box. To the right of this, the 'code' field contains the value '430193006' and is also highlighted with a red box. The 'Matches' field shows 'System (opf)'.

The result details each procedure that fits the specified criteria.

## Interoperability Land Event Guide

Raw Message

```
{
  "resourceType": "Bundle",
  "id": "0e55c80e-966f-4db6-bfb5-d63de0263813",
  "meta": {
    "lastUpdated": "2020-01-17T17:08:15.336+00:00"
  },
  "type": "searchset",
  "total": 1,
  "link": [
    {
      "relation": "self",
      "url": "https://wxlydjsx-bcbsm.interopland.com/five-lakes-health-system/fhir/Procedure?_pretty=true&code=430193006&subject=1754"
    }
  ],
  "entry": [
    {
      "fullUrl": "https://wxlydjsx-bcbsm.interopland.com/five-lakes-health-system/fhir/Procedure/20727",
      "resource": {
        "resourceType": "Procedure",
        "id": "20727",
        "meta": {
          "versionId": "1",
          "lastUpdated": "2020-01-10T22:36:50.000+00:00"
        },
        "text": {
          "status": "generated",
          "div": "<div xmlns='http://www.w3.org/1999/xhtml'>This is a simple example with only plain text</div>"
        },
        "extension": [
          {
            "url": "http://mihin.org/extension/copyright",
            "valueString": "Copyright 2014-2019 Michigan Health Information Network Shared Services. Licensed under the Apache License, Version 2.0 (the 'License'); you may not use this file except in compliance with the License. You may obtain a copy of the License at http://www.apache.org/licenses/LICENSE-2.0. Unless required by applicable law or agreed to in writing, software distributed under the License is distributed on an 'AS IS' BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied. See the License for the specific language governing permissions and limitations under the License."
          }
        ]
      }
    }
  ]
}
```

Server: Local Tester ▾ Source Code About This Server

```
    ],
    "status": "completed",
    "code": {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "430193006",
          "display": "Medication Reconciliation (procedure)"
        }
      ]
    },
    "subject": {
      "reference": "Patient/1754",
      "display": "Alex Melvin Kaufman"
    },
    "encounter": {
      "reference": "Encounter/20723",
      "display": "Outpatient_Encounter"
    },
    "performedPeriod": {
      "start": "2021-01-22T13:00:00+00:00",
      "end": "2021-01-22T13:00:00+00:00"
    },
    "performer": [
      {
        "actor": {
          "reference": "Practitioner/49",
          "display": "Regina Gould Melton MD"
        }
      }
    ],
    "location": {
      "reference": "Location/29",
      "display": "Lansing Northside Urgent Care Center"
    },
    "reasonReference": [
      {
        "reference": "https://five-lakes-health-system/fhir/DocumentReference/20724",
        "display": "CCD of Encounter-17825[2021/01/22: Outpatient_Encounter, Alex Melvin Kaufman[40] saw Regina Gould Melton MD in Lansing Northside Urgent Care Center]"
      }
    ]
  },
  "search": {
    "mode": "match"
  },
  "response": {
    "status": "201 Created",
    "etag": "W/\"1\""
  }
}
```

The performedPeriod field shows when the procedure began (“start”) and concluded (“end”). To complete the chart chase and determine whether the HEDIS quality measure was satisfied for this patient’s hospital visit, the end subfield of performedPeriod can be

## Interoperability Land Event Guide

compared to the date of the discharge form to determine whether the procedure occurred within the 30 day time period after the discharge.



## Scenario 2- Calculating total patients in a health system who meet HEDIS TRC eligibility criteria

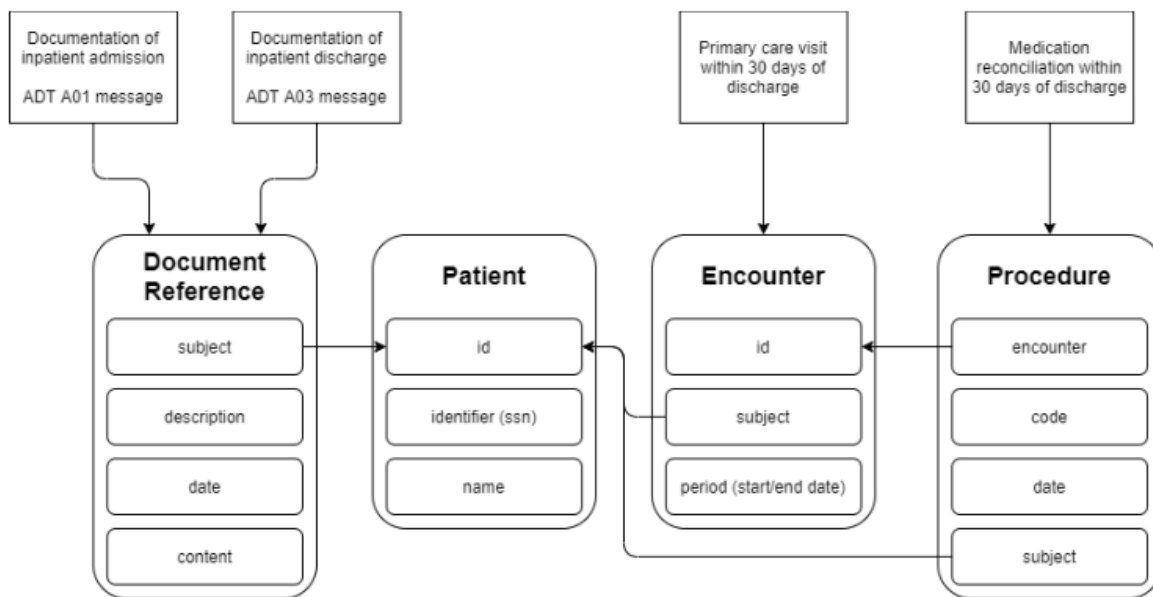
The current validation process for substantiating completed HEDIS measures includes querying medical facilities for missing documentation, also known as the “chart chase”. This process requires human intervention to conduct chart chasing to gather additional documentation for audit. The challenge for this scenario is to determine cases where the HEDIS criteria are *almost* met but missing one or more pieces of data.

Conceptualize a process that queries the EHR to return the data required for the audit.

HEDIS TRC – Transitions of Care measure requires four data points:

5. Documentation of receipt of inpatient admission
  - Documentation of receipt of inpatient admission is represented using a FHIR **DocumentReference** resource containing a ADT A01 message
6. Documentation of receipt of discharge information
  - Documentation of receipt of inpatient discharge is represented using a FHIR **DocumentReference** resource containing a ADT A03 message
7. Follow-up visit with primary care provider within 30 days of discharge
  - Follow-up visit with primary care provider within 30 days of discharge is represented using a FHIR **Encounter** Resource
8. Medication reconciliation within 30 days of discharge
  - Documented as a **Procedure** resource with a Snomed code for Med Reconciliation procedure: 430193006

The challenge is to retrieve groups of records for these situations where a single piece of data is missing – such as when all conditions are met except the follow-up visit, or the medication reconciliation. **As it could be difficult to acquire all of the necessary data in a single query, the use of external APIs and custom code may be required for this portion.**



## Queries for Scenario 2- Using the HAPI FHIR Interface

### Query 1 – All Admission Documents

When performing queries that return a potentially large number of results, additional features of the HAPI FHIR interface become relevant. The sort dropdowns allow the specification of an order for the results to be returned in and the limit field specifies the number of results to return per page.

The screenshot shows the HAPI FHIR interface with the following fields and options:

- Search:** A blue button with a magnifying glass icon and the text "Search".
- Search Parameters:** A section with the text "Optionally add parameter(s) to the search". It includes a green "+" button, a dropdown menu with "description - Human-readable description", and a "Matches" field showing "A01".
- Includes:** A section with the text "Also include resources which are referenced by the search results". It contains several checkboxes for resource types: DocumentReference:authenticator, DocumentReference:author, DocumentReference:custodian, DocumentReference:encounter, DocumentReference:patient, DocumentReference:related, DocumentReference:relatesto, and DocumentReference:subject.
- Sort Results:** A section with "Sort By" set to "date" and "Direction" set to "asc".
- Other Options:** A section with a "Limit" field set to "50".

In addition to the raw JSON, the response contains individual links to each returned item. Clicking one of the “Read” buttons will launch a query by id for that item in a new window.

## Interoperability Land Event Guide
























### Result Body

JSON bundle  
(240902 bytes)

Bundle contains 50 / 214 entries

Prev Page

Next Page

ID		Updated
 Read	 Update	DocumentReference/14981/_history/1
		 Rectangular Snip
 Read	 Update	DocumentReference/15274/_history/1
 Read	 Update	DocumentReference/15998/_history/1
 Read	 Update	DocumentReference/16345/_history/1
 Read	 Update	DocumentReference/16270/_history/1
 Read	 Update	DocumentReference/16779/_history/1
 Read	 Update	DocumentReference/17211/_history/1
 Read	 Update	DocumentReference/17169/_history/1
 Read	 Update	DocumentReference/17288/_history/1
 Read	 Update	DocumentReference/17535/_history/1
 Read	 Update	DocumentReference/17664/_history/1

### Query 2 – All Discharge Documents

As was the case when examining a single patient's records, bulk retrieval of discharge documents is almost identical to bulk retrieval of admission documents.

**Search Parameters** Optionally add parameter(s) to the search

description - Human-readable description

Matches A03

**Includes** Also include resources which are referenced by the search results

☐ \*

☐ DocumentReference:authenticator

☐ DocumentReference:author

☐ DocumentReference:custodian

☐ DocumentReference:encounter

☐ DocumentReference:patient

☐ DocumentReference:related

☐ DocumentReference:relatedto

☐ DocumentReference:subject

**Sort Results**

Sort By date

Direction asc

**Other Options**

Limit 50

The result list can be examined to determine which patients need to have a medication reconciliation procedure in order to satisfy the HEDIS measure and when the 30-day windows for each of those procedures begin.

```
{
  "subject": {
    "reference": "Patient/4206",
    "display": "Jeffrey Paul Montgomery"
  },
  "date": "2020-01-05T01:00:00.000+00:00",
  "authenticator": {
```

### Query 3 – All Medication Reconciliation Procedures

Querying for all Medication Reconciliation procedures follows the same basic form as the DocumentReference bulk queries.

Search Parameters

Optionally add parameter(s) to the search

+

code - A code to identify a procedure

Matches

System

(opt)

Code

430193006

Includes

Also include resources which are referenced by the search results

\*

Procedure:based-on

Procedure:encounter

Procedure:instantiates-canonical

Procedure:location

Procedure:part-of

Procedure:patient

Procedure:performer

Procedure:reason-reference

Procedure:subject

Sort Results

Sort By

date

Direction

asc

Other Options

Limit

50

HEDIS TRC compliance can now be determined by comparing the medication reconciliation procedures returned by this query to the list of discharge documents returned by the previous one.

```
{
  "code": {
    "coding": [
      {
        "system": "http://snomed.info/sct",
        "code": "430193006",
        "display": "Medication Reconciliation (procedure)"
      }
    ]
  },
  "subject": {
    "reference": "Patient/185",
    "display": "Arlene Day Travis"
  },
  "encounter": {
    "reference": "Encounter/187",
    "display": "Outpatient_Encounter"
  },
  "performedPeriod": {
    "start": "2016-01-27T13:20:00+00:00",
    "end": "2016-01-27T13:20:00+00:00"
  }
}
```

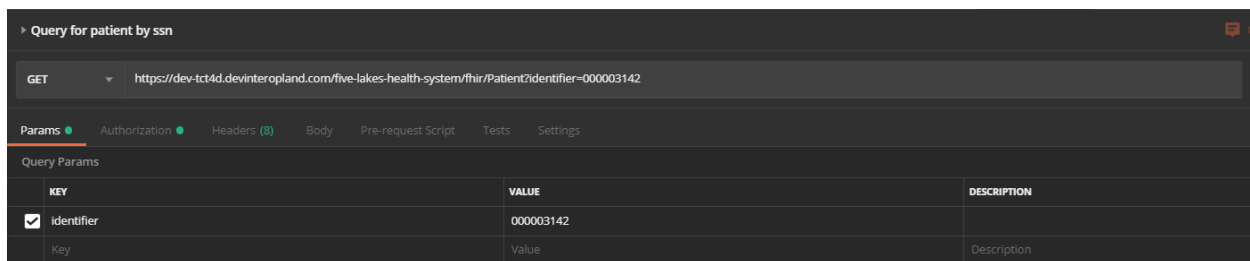
Note that the patient's displayed name in the subject field is not guaranteed to be unique, so comparisons should rely on the reference id instead



## Rest Client Guide

### Performing a Basic Query in Postman for HEDIS/Stars Transition of Care Measure

Postman is a tool for API testing that helps organize HTTP requests before sending them to a server. In the example below, we've used set the url to: <https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/Patient?identifier=000003142>. After clicking the 'Send' button in Postman, an HTTP GET request is generated and sent to the server to query for any **Patient** resources with an identifier(ssn) of 000003142.



### Queries for Scenario 2-Using the REST Client

**Follow-up visit with primary care provider within 30 days of discharge** is represented using a **FHIR Encounter Resource**

- <https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/Encounter?date=ge2025-01-01&date=le2025-01-31&patient=170>

**A medication reconciliation** is represented by a **Procedure** having Snomed code 430193006

- [https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/Patient?\\_has:Procedure:subject:code=430193006](https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/Patient?_has:Procedure:subject:code=430193006)

Including **Additional Resources** can be done with use of the **\_include** or **\_revinclude** query parameters. These can be used when the base **Resource** (in this case, **Patient**) has a link to an external resource, or if the external resource (**Encounter**), links back to it.

## Interoperability Land Event Guide

- [https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/Patient?identifier=000002875&\\_count=1&\\_revinclude=Encounter:subject](https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/Patient?identifier=000002875&_count=1&_revinclude=Encounter:subject)

In order to deal with the limitations of the Restful API, use of external code libraries and APIs may be required to handle more complex queries. A supplementary guide to this one contains a small snippet generated from the HAPI FHIR java project that exemplifies a more complex querying scenario, and participants in the Connecathon should feel free to use their own preferred FHIR R4 libraries if they wish.

## Appendix

### Querying FHIR Resources: A Supplementary Guide to the Event Guide

FHIR servers provide a number of ‘Resources’, or health-care related data objects that can be created, read, updated, or deleted. These resources have a variety of uses and have varied industry adoption. For the curious, a full list of resources and their level of maturity can be found here - <https://www.hl7.org/fhir/resourcelist.html>.

Resources can represent a variety of topics which may be useful to different organizations. For example, hospitals would likely need the **Patient** resource, as well as **Observations**, **Immunizations**, and **AllergyIntolerances**. Insurance companies may be more concerned with **Procedures**, **Claims**, and **Coverage** resources. University research labs might use the **ResearchSubject** or **SubstanceNucleicAcid** resource. There are also resources needed for server infrastructure, such as the **CapabilityStatement**, which is what the server uses to advertise what version and resources it knows about, and the **OperationDefinition**, which advertises what cool things the server can do.

For this Connectathon, we’re principally focused on the ‘**Patient**’ resource and the ‘**DocumentReference**’ resources. We’ll also be using the ‘**Encounter**’ resource, searching the ‘**Procedure**’ resource for a certain value, and possibly using the ‘**MedicationStatement**’ resource.

## Interoperability Land Event Guide

Throughout the exercise, we'll be sending 'GET' requests in Postman to query for the aforementioned FHIR resources using the RESTful API.

In Postman, a GET request to:

`https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/Patient`

Will yield you something like this:

```
{
  "resourceType": "Bundle",
  "id": "bc061cc1-96e2-48d5-be68-a5ae89b67db2",
  "meta": {
    "type": "searchset",
    "link": [
      {
        "entry": [
          {
            "fullUrl": "https://dev-tct4d.devinteropland.com/five-lakes-health-system/fhir/Patient/84",
            "resource": {
              "resourceType": "Patient",
              "id": "84",
              "meta": {
                "text": {
                  "extension": [
                    {
                      "identifier": [
                        {
                          "active": true,
                          "name": [
                            {
                              "telecom": [
                                {
                                  "gender": "female",
                                  "birthDate": "1972-02-07",
                                  "address": [
                                    {
                                      "search": {

```

(The shortcut to collapse results in Postman is Alt-0/Shift-Alt-0, numpad 0 doesn't work for it)

You'll notice the fields there match up roughly to the [resource guide](#) from HL7 FHIR listed below. The Σ flag in the screenshot indicates that these fields will show up in a patient **summary** request, which is what our request was for. Likewise, you'll notice some fields absent in the results – this is either because there's no data, or you need to request a non-summary version using a more focused request (like `http://[url]/patient/[id]`).

# Interoperability Land Event Guide

## Structure

Name	Flags	Card.	Type	Description & Constraints
Patient	<b>N</b>		DomainResource	Information about an individual or animal receiving health care services Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension An identifier for this patient
identifier	Σ	0..*	Identifier	
active	? Σ	0..1	boolean	Whether this patient's record is in active use
name	Σ	0..*	HumanName	A name associated with the patient
telecom	Σ	0..*	ContactPoint	A contact detail for the individual
gender	Σ	0..1	code	male   female   other   unknown AdministrativeGender (Required)
birthDate	Σ	0..1	date	The date of birth for the individual
deceased[x]	? Σ	0..1		Indicates if the individual is deceased or not
deceasedBoolean			boolean	
deceasedDateTime			dateTime	
address	Σ	0..*	Address	An address for the individual
maritalStatus		0..1	CodeableConcept	Marital (civil) status of a patient MaritalStatus (Extensible)
multipleBirth[x]		0..1		Whether patient is part of a multiple birth
multipleBirthBoolean			boolean	
multipleBirthInteger			integer	
photo		0..*	Attachment	Image of the patient
contact	I	0..*	BackboneElement	A contact party (e.g. guardian, partner, friend) for the patient + Rule: SHALL at least contain a contact's details or a reference to an organization
relationship		0..*	CodeableConcept	The kind of relationship Patient Contact Relationship (Extensible)
name		0..1	HumanName	A name associated with the contact person
telecom		0..*	ContactPoint	A contact detail for the person
address		0..1	Address	Address for the contact person
gender		0..1	code	male   female   other   unknown AdministrativeGender (Required)
organization	I	0..1	Reference(Organization)	Organization that is associated with the contact
period		0..1	Period	The period during which this contact person or organization is valid to be contacted relating to this patient
communication		0..*	BackboneElement	A language which may be used to communicate with the patient about his or her health
language		1..1	CodeableConcept	The language which can be used to communicate with the patient about his or her health Common Languages (Preferred) but limited to AllLanguages
preferred		0..1	boolean	Language preference indicator
generalPractitioner		0..*	Reference(Organization   Practitioner   PractitionerRole)	Patient's nominated primary care provider
managingOrganization	Σ	0..1	Reference(Organization)	Organization that is the custodian of the patient record
link	? Σ	0..*	BackboneElement	Link to another patient resource that concerns the same actual person
other	Σ	1..1	Reference(Patient   RelatedPerson)	The other patient or related person resource that the link refers to
type	Σ	1..1	code	replaced-by   replaces   refer   sealso LinkType (Required)

## Example query structure

[base URL] [organization name] ["/fhir/"] [resourceType]

<https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//five-lakes-health-system/fhir/DocumentReference>

Returns all DocumentReference resources from the Five Lakes Health System PIT (default number of records is 20 and maximum records possible for return is 200)

Example of a Document Reference returned:

ResourceType	DocumentReference
id	29106
masterIdentifier	2deaf4a0-1b3a-4568-b129-35852ea49c2d
identifier	2deaf4a0-1b3a-4568-b129-35852ea49c2d
description	A03 of encounter Id = 2deaf4a0-1b3a-4568-b129-35852ea49c2d
Subject.reference	Patient/424
Context.encounter.reference	Encounter/29102
Period.start	2023-05-12T00:00:00+00:00
Period.end	2023-05-12T00:00:00+00:00



### Advanced query formatting

Now let's get the DocumentReference resources from a patient by their SSN

<https://dev-tct4c.devinteropland.com/new-hope-services/fhir/DocumentReference?subject:Patient.identifier=000002885>

With "?subject:Patient.identifier=000002885" you can replace 000002885

with other SSN to find other patients DocumentReference resources.

ResourceType	DocumentReference
id	29106
masterIdentifier	2deaf4a0-1b3a-4568-b129-35852ea49c2d
identifier	2deaf4a0-1b3a-4568-b129-35852ea49c2d
description	A03 of encounter Id = 2deaf4a0-1b3a-4568-b129-35852ea49c2d
Subject.reference	Patient/424
Context.encounter.reference	Encounter/29102
Period.start	2023-05-12T00:00:00+00:00
Period.end	2023-05-12T00:00:00+00:00

### Data linkage

You may find it useful to conceptualize the data as a SQL table, despite the back-end technology being No-SQL. In doing this, we get the useful mechanism of Foreign Keys to help us navigate around and discover data relationships.

The equivalent mechanism is in place for our data as well, in the form of References. These are incredibly valuable when crafting more complex queries, such as the types we'll see in the next section. These are best discovered through the individual resource's documentation on the HL7 FHIR site, and searching for 'Reference' under the type column - <https://www.hl7.org/fhir/patient.html>

## Interoperability Land Event Guide

### Structure

Name	Flags	Card.	Type	Description & Constraints
Patient	N		DomainResource	Information about an individual or animal receiving health care services Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	An identifier for this patient
active	?!	Σ 0..1	boolean	Whether this patient's record is in active use
name	Σ	0..*	HumanName	A name associated with the patient
telecom	Σ	0..*	ContactPoint	A contact detail for the individual
gender	Σ	0..1	code	male   female   other   unknown AdministrativeGender (Required)
birthDate	Σ	0..1	date	The date of birth for the individual
generalPractitioner		0..*	Reference(Organization   Practitioner   PractitionerRole)	Patient's nominated primary care provider
managingOrganization	Σ	0..1	Reference(Organization)	Organization that is the custodian of the patient record
link	?!	Σ 0..*	BackboneElement	Link to another patient resource that concerns the same actual person
other	Σ	1..1	Reference(Patient   RelatedPerson)	The other patient or related person resource that the link refers to
type	Σ	1..1	code	replaced-by   replaces   refer   seealso LinkType (Required)

Likewise, you'll find most resources on the HL7 FHIR site have a paragraph just above the "Resource Content" section that says 'This resource is referenced by:.', followed by a list of resources.

For reference, the current HL7 R4 paragraph lists all of these resources that link to Patient:

[Annotation](#), [Signature](#), [Account](#), [AdverseEvent](#), [AllergyIntolerance](#), [Appointment](#), [AppointmentResponse](#), [AuditEvent](#), [Basic](#), [BiologicallyDerivedProduct](#), [BodyStructure](#), [CarePlan](#), [CareTeam](#), [ChargeItem](#), [Claim](#), [ClaimResponse](#), [ClinicalImpression](#), [Communication](#), [CommunicationRequest](#), [Composition](#), [Condition](#), [Consent](#), [Contract](#), [Coverage](#), [CoverageEligibilityRequest](#), [CoverageEligibilityResponse](#), [DetectedIssue](#), [Device](#), [DeviceRequest](#), [DeviceUseStatement](#), [DiagnosticReport](#), [DocumentManifest](#), [DocumentReference](#), [Encounter](#), [EnrollmentRequest](#), [EpisodeOfCare](#), [ExplanationOfBenefit](#), [FamilyMemberHistory](#), [Flag](#), [Goal](#), [Group](#), [GuidanceResponse](#), [ImagingStudy](#), [Immunization](#), [ImmunizationEvaluation](#), [ImmunizationRecommendation](#), [Invoice](#), [List](#), [MeasureReport](#), [Media](#), [MedicationAdministration](#), [MedicationDispense](#), [MedicationRequest](#), [MedicationStatement](#), [MolecularSequence](#), [NutritionOrder](#), [Observation](#), itself, [Person](#), [Procedure](#), [Provenance](#), [QuestionnaireResponse](#), [RelatedPerson](#), [RequestGroup](#), and others.

In theory, you can get a very complete picture of a Patient resource in one json request by using **\_revinclude** on the that whole list. In practice, not every system will implement all resources, or security features may be in place, so your results may vary. Note that overzealous usage of **\_revincludes** may stress the server, so judicious usage is advised.

For an example, examine the parameters in the following query:

<https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//new-hope-services/fhir/Patient?identifier=000002867& count=1& revinclude=DocumentReference:subject& revinclude=Encounter:subject>

- **\_count=1**
  - Limits our resultset to only one patient, to save on server load.
- **Identifier=000002867**
  - Patient resource has SSN as identifier, so we can search on it.



- **\_revinclude=DocumentReference:subject**
  - (Fetches and includes DocumentReferences that reference the patient)
- **\_revinclude=Encounter:subject**
  - (Fetches and includes Encounters that reference the patient)

## Crafting more complex queries to answer questions

The FHIR server offers a moderately powerful querying functionality accessible through the same endpoints we've been using. It's capable of some simple join operations, as well as simple filtering. If you're familiar with SQL, it's similar to the JOIN and WHERE statements albeit with limitations.

Here's a basic summary query for 20 patients:

<https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//new-hope-services/fhir/Patient>

And here's a more complex query for 20 patients that have **DocumentReferences** resources that refer to the patient and have A01 in their description. Note that the query does **NOT** include the **DocumentReferences** in the result.

[https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//new-hope-services/fhir/Patient?\\_has:DocumentReference:patient:description=A01](https://<<ORGCODE>>-bcbsm.interopland.com/five-lakes-health-system//new-hope-services/fhir/Patient?_has:DocumentReference:patient:description=A01)

The **\_has** parameter utilizes references on the **DocumentReference** that point to patient (as seen in the last section).

Similar functionality can be achieved with **\_revinclude**, and this would also include the **DocumentReference** in the json results. (**\_has** can do this too if **\_contained=true** is also in the query)

## Limitations to out-of-the-box queries

- No sub-queries without customizing the server
- (i.e.: can't query resultset from a complex query)
- No programmatically extended ranges
- No way to dynamically query 'between 1/1/2020 and 30 days from then



## Workarounds to these limitations

- FHIR client libraries implementing the desired resources for your desired standard version (currently: **R4**)
- Available in java, python, .net
- Use lists/arrays to hold the results, then foreach over them to filter/process or programmatically perform follow-up queries against FHIR server as needed.

```
public static void main(String[] args) {
    FhirContext ctx = FhirContext.forR4();
    String serverBase = "https://dev-tct4d.devinteropland.com/five-lakes-health-
system/fhir/";

    IGenericClient gclient = ctx.newRestfulGenericClient(serverBase);
    gclient.registerInterceptor(
        new BasicAuthInterceptor("interop_pit", "your-password-goes-here"));

    class userDischargeDate {
        String userId;
        String ADT30DayRangeStart;
        String ADT03DischargeEndDate;
        boolean followupEncounter = false;

        public userDischargeDate(String inUserId, Date ADT03DischargeDate) {
            userId = inUserId;
            SimpleDateFormat sdf = new SimpleDateFormat("yyyy-MM-dd");
            ADT30DayRangeStart = sdf.format(ADT03DischargeDate);
            ADT03DischargeEndDate = sdf
                .format(DateUtils.addDays(ADT03DischargeDate, 30));
        }
    }

    List<userDischargeDate> Adt03sWithUsers = new ArrayList<userDischargeDate>();
    List<String> followUpEncountersWithin30Days;

    Bundle ADT03Results = gclient.search().forResource(DocumentReference.class)
        .where(DocumentReference.DESRIPTION.contains().value("A03"))
        .returnBundle(Bundle.class).execute();

    ADT03Results.getEntry().forEach((entry) -> {
        DocumentReference docRef = (DocumentReference) entry.getResource();
        if (docRef.hasSubject()) {
            Reference subject = docRef.getSubject();
            Adt03sWithUsers
                .add(new userDischargeDate(subject.getId(), docRef.getDate()));
        }
    });

    Adt03sWithUsers.forEach((userDischargeDate) -> {
        Bundle EncounterResults = gclient.search().forResource(Encounter.class)
            .where(Encounter.PATIENT.hasId(userDischargeDate.userId))
            .and(Encounter.DATE.afterOrEquals()
                .day(userDischargeDate.ADT30DayRangeStart))
            .and(Encounter.DATE.beforeOrEquals()
                .day(userDischargeDate.ADT30DayRangeStart))
            .returnBundle(Bundle.class).execute();

        if (EncounterResults.hasEntry()) {
            userDischargeDate.followupEncounter = true;
            System.out.println("Patient: " + userDischargeDate.userId
                + " had a follow-up visit within 30 days");
        }
    })
}
```

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