

FHIR Terminology Services 101

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Who am I?

- Dion McMurtrie
- Team Lead, FHIR and Terminology Tooling
- Australian e-Health Research Centre



Learning Objectives

Understand the basics of the FHIR Terminology Service

Identify key resources and operations

CodeSystems, ValueSets, ConceptMaps.

\$lookup, \$expand, \$validate-code, \$translate.

Understand practical use cases

Appreciate the benefits

efficiency, consistency, easier maintenance, interoperability...

Be aware of global adoption and opportunities

National and global terminology services

Know where to find resources and tools

What's so important about terminology?

- Good information is critical to the delivery of safe and high-quality health care
- Reliable data is essential for monitoring, analysis and policy development
- Information and data in health is comprised of complex language
 - standardisation of this language and meaning is an ongoing process
- To apply sophisticated computing tools
 - for high-quality and safe information exchange, analysis, reporting, decision support
 - we need coded, structured, computable data
- **Terminology** is the **codified meaning**, standards like **FHIR** are the **structure**

What is the FHIR Terminology Service?

...a service that lets healthcare applications

make use of codes and value sets

without having to become experts in

the fine details of code system, value set and concept map resources,

and the underlying code systems and terminological principles.

How does terminology affect what I'm doing in FHIR?

Data entry

- Quickly find the right code to record in a specific context

Validation

- Is the code I've been given valid for this context?

Display / understanding

- Tell me about this code/set of codes (from this code system)

Mapping

- Find me a code in that set related to the code I have from this set

Analytics

- Arrange this coded data into categories so I can understand it

Authoring

- I need to make my own CodeSystem/ValueSet/ConceptMap

- Server: I want my server to be smart about terminology

What's a “binding”?

Formal declaration of allowable values for specific data elements

- Foundational for consistency, integrity, and interoperability of data

Reference to a ValueSet that defines the allowable values

Binding strengths:

required	To be conformant, the concept in this element SHALL be from the specified value set
extensible	To be conformant, the concept in this element SHALL be from the specified value set if any of the codes within the value set can apply to the concept being communicated. If the value set does not cover the concept (based on human review), alternate codings (or, data type allowing, text) may be included instead.
preferred	Instances are encouraged to draw from the specified codes for interoperability purposes but are not required to do so to be considered conformant.
example	Instances are not expected or even encouraged to draw from the specified value set. The value set merely provides examples of the types of concepts intended to be included.

Where do codes live in FHIR?

‘code’

- Just a code!
- CodeSystem is fixed by the underlying Resource

‘coding’

- system, version, code, display, userSelected

CodeableConcept

- Codings (..*) plus text

Quantity

- Has both *system* and *code* elements for unit

Searching: ‘token’

- system|code
- code (any system)
- |code (no system)
- system| (any code)
- Modifiers:
 - :text, :not (boring!)
 - :below, :above (hierarchy)
 - :in, :not-in (ValueSets)
 - :of-type (Identifiers)

```

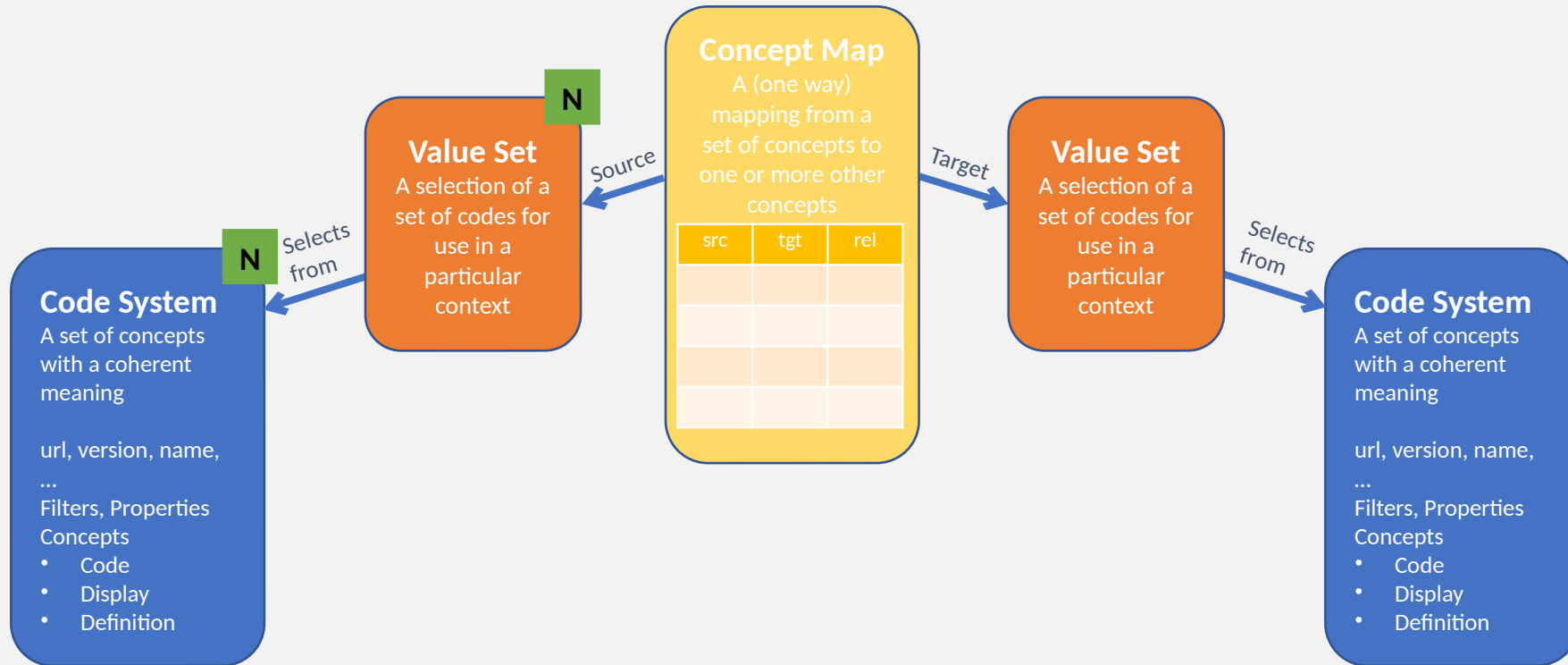
{
  "resourceType": "Encounter",
  "status": "in-progress",
  "class": {
    "system": "http://terminology.hl7.org/CodeSystem/v3-ActCode",
    "code": "AMB"
  },
  "reasonCode": [
    {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "840544004",
          "version": "http://snomed.info/sct/900000000000207008/version/20200309",
          "userSelected": true
        },
        {
          "system": "http://hl7.org/fhir/sid/icd-10",
          "code": "U07.2"
        }
      ],
      "text": "Suspected COVID-19"
    }
  ]
}

```

code
coding

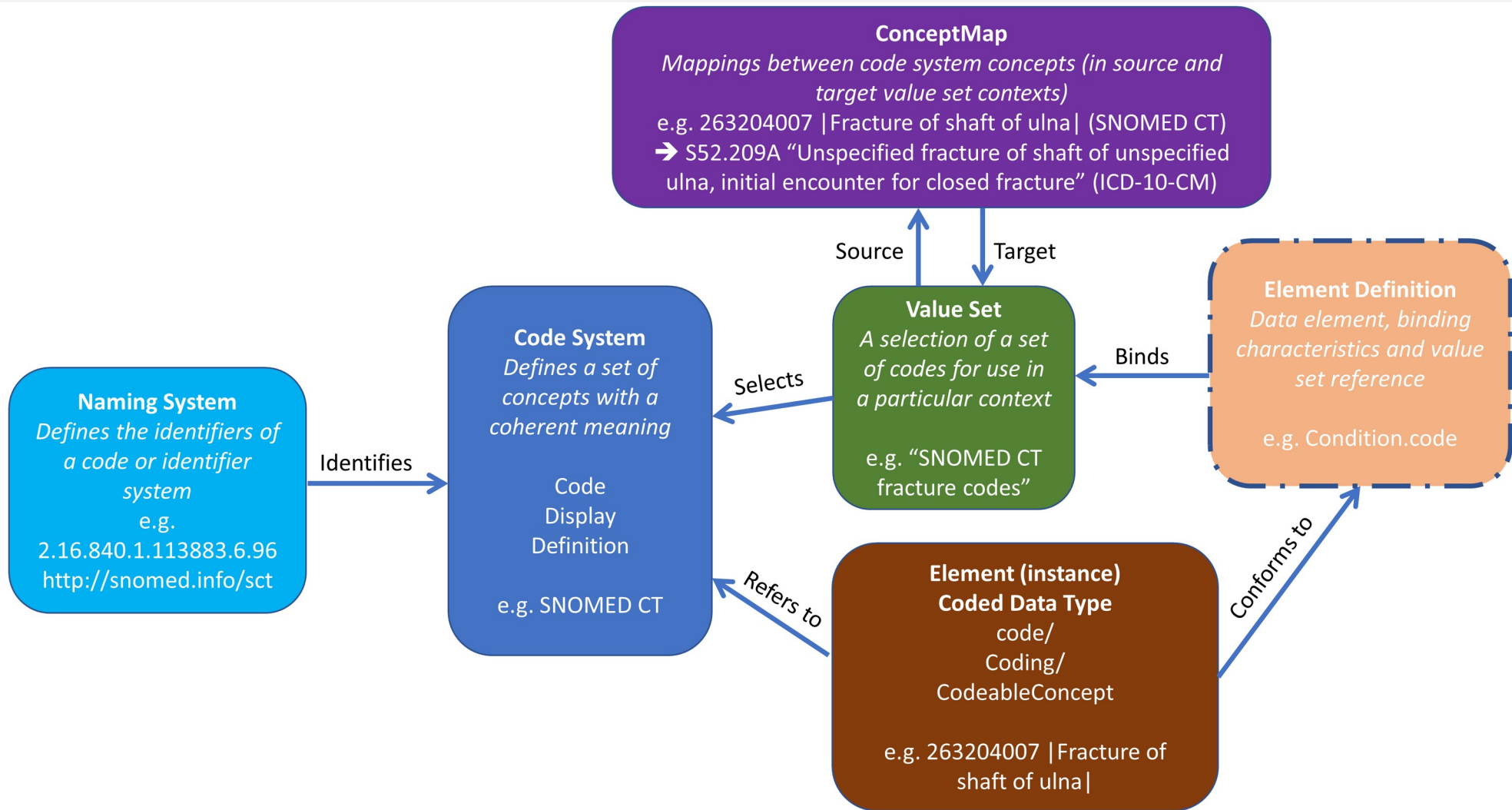
CodeableConcept

FHIR Terminology Resources



Key operations

CodeSystem	\$lookup	Get details about a code/system or a Coding – definition, status, designations, properties...
	\$validate-code	Validate that a coded value is in the code system
	\$subsumes	Test the subsumption relationship between two codes (equivalent, subsumes, subsumed-by, and not-subsumed)
ValueSet	\$expand	Get the collection of codes that are in a ValueSet, optionally filtered
	\$validate-code	Validate that a code is in the ValueSet
ConceptMap	\$translate	Translate a code from one value set to another based on a ConceptMap



Well known terminologies

Terminologies have specific mappings into FHIR terminology resources, with standardised CodeSystems

- Standard CodeSystem filters/properties
- Implicit ValueSets
- Implicit ConceptMaps

e.g. SNOMED-CT, LOINC, ICD10...

Well-known Terminologies: SNOMED-CT & LOINC

- <http://snomed.info/sct>
(/[edition](/version/[date]))?)?
- Properties: all relationships, normalForm, moduleId ...
- Filters: relationships, subsumption, refset, ECL expressions
- Implicit ValueSets
 - All codes: http://snomed.info/sct?fhir_vs
 - By subsumption: http://snomed.info/sct?fhir_vs=isa/404684003
 - List of refsets: http://snomed.info/sct?fhir_vs=refset
 - All codes in a refset: http://snomed.info/sct?fhir_vs=refset/734138000
 - All codes that match an ECL expression: http://snomed.info/sct?fhir_vs=ecl/* :
363698007|Finding site| = 85562004|Hand structure|
- Implicit ConceptMaps
 - Historical associations: http://snomed.info/sct?fhir_cm=9000000000000527005
- <http://loinc.org/>(/[version])?
- Properties: axes, STATUS, ...
- Filters: by multi-axial hierarchy, by part, ...
- Implicit ValueSets
 - All codes: <http://loinc.org/vs>
 - By multi-axial hierarchy: <http://loinc.org/vs/LP14635-4>
 - By Answer List: <http://loinc.org/vs/LL715-4>

Basic use cases – data entry

- Choose (ideally standard!) CodeSystem/s
- Choose or define ValueSet/s
- Small ValueSets
 - Picklists populated from **\$expand**
- Large ValueSets
 - Typeahead widget with **\$expand?filter=xxx**

<http://snomed.org/ui>

The screenshot displays the SNOMED CT Search Demo interface. At the top, it shows the 'SNOMED CT Search Demo' title and a 'Snomed Terminology Server' dropdown menu with the URL 'https://r4.ontoserver.csiro.au/fhir'. Below this, a blue header bar contains patient information: 'MEDD, Snowy', 'DOB: 2001-08-28', 'Age: 18', 'Sex: Male', and 'MRN: 123456'. A red warning banner indicates 'High Adverse Reaction Risks' for 'Penicillin'. On the left, a dark sidebar lists navigation options: 'Patient Details', 'Encounter', 'Allergies / Adverse Reactions', 'Medication', 'Investigations', 'Immunizations', and 'Patient Summary'. The main content area is titled 'Current Encounter' and includes a 'Date/Time' field with the value 'Tue Jan 14 2020 07:15:53 GMT+0800 (Philippine Standard Time)'. Below this are three input fields: 'Reason for Encounter', 'Diagnosis' (with a 'boost' toggle), and 'Procedure'. Each field has a search icon (S) and an information icon (i). The 'Diagnosis' field also has a 'Diagnosis Note' field. The 'Procedure' field has a 'Laterality' dropdown menu. An 'Add' button is located at the bottom right of the form.

Example \$expand

[GET /ValueSet/\\$expand?url=http://hl7.org/fhir/ValueSet/administrative-gender](http://hl7.org/fhir/ValueSet/administrative-gender)

Accept: application/fhir+json

```
{
  "resourceType": "ValueSet",
  "language": "en",
  "url": "http://hl7.org/fhir/ValueSet/administrative-gender",
  "version": "4.0.0",
  "name": "AdministrativeGender",
  "expansion": {
    "identifier": "d71ae791-26d5-4cb3-9774-83235a17f99e",
    "timestamp": "2019-06-08T19:11:56+10:00",
    "total": 4,
    "parameter": [
      {
        "name": "version",
        "valueUri": "http://hl7.org/fhir/administrative-gender?version=4.0.0"
      },
      {
        "name": "count",
        "valueInteger": 2147483647
      },
      {
        "name": "offset",
        "valueInteger": 0
      }
    ],
    "contains": [
      {
        "system": "http://hl7.org/fhir/administrative-gender",
        "code": "male",
        "display": "Male"
      },
      {
        "system": "http://hl7.org/fhir/administrative-gender",
        "code": "female",
        "display": "Female"
      },
      {
        "system": "http://hl7.org/fhir/administrative-gender",
        "code": "other",
        "display": "Other"
      },
      {
        "system": "http://hl7.org/fhir/administrative-gender",
        "code": "unknown",
        "display": "Unknown"
      }
    ]
  }
}
```

Example: \$expand with filter

[GET /ValueSet/\\$expand?url=http://loinc.org/vs&filter=urinalysis&count=3](http://loinc.org/ValueSet/$expand?url=http://loinc.org/vs&filter=urinalysis&count=3)

Accept: application/fhir+json

```
{
  "resourceType": "ValueSet",
  "language": "en",
  "url": "http://loinc.org/2.64/vs",
  "name": "LOINC Value Set for All Codes",
  "status": "active",
  "expansion": {
    "identifier": "8b77a009-2480-4add-887b-d45a3626c584",
    "timestamp": "2019-06-08T19:15:08+10:00",
    "total": 52,
    "parameter": [
      {
        "name": "version",
        "valueUri": "http://loinc.org?version=2.64"
      },
      {
        "name": "count",
        "valueInteger": 3
      },
      {
        "name": "offset",
        "valueInteger": 0
      },
      {
        "name": "filter",
        "valueString": "urinalysis"
      }
    ]
  },
  "contains": [
    {
      "system": "http://loinc.org",
      "code": "LP32744-2",
      "display": "Urinalysis"
    },
    {
      "system": "http://loinc.org",
      "code": "LP14150-4",
      "display": "Urinalysis panel"
    },
    {
      "system": "http://loinc.org",
      "code": "LP74376-2",
      "display": "Urinalysis studies"
    }
  ]
}
```

\$expand using context

GET /ValueSet/\$expand?context=Medication.status

Accept: application/fhir+json

```

{
  "resourceType": "ValueSet",
  "language": "en",
  "url": "http://hl7.org/fhir/ValueSet/medication-status|4.0.0",
  "version": "4.0.0",
  "name": "Medication Status Codes",
  "expansion": {
    "identifier": "e8e479c8-2aa8-41bc-bc72-5c88de700310",
    "timestamp": "2019-06-08T19:22:05+10:00",
    "total": 3,
    "parameter": [
      {
        "name": "version",
        "valueUri": "http://hl7.org/fhir/CodeSystem/medication-status?version=4.0.0"
      },
      {
        "name": "count",
        "valueInteger": 2147483647
      },
      {
        "name": "offset",
        "valueInteger": 0
      }
    ],
    "contains": [
      {
        "system": "http://hl7.org/fhir/CodeSystem/medication-status",
        "code": "entered-in-error",
        "display": "Entered in Error"
      },
      {
        "system": "http://hl7.org/fhir/CodeSystem/medication-status",
        "code": "active",
        "display": "Active"
      },
      {
        "system": "http://hl7.org/fhir/CodeSystem/medication-status",
        "code": "inactive",
        "display": "Inactive"
      }
    ]
  }
}

```

Basic use cases – validating data

Validate a code (and display text) against a ValueSet

- Existing ValueSet (including implicit ValueSets) or POST one
- Code as code/system/version, or coding, or CodeableConcept (multiple)
- Determine whether the code is included in the ValueSet
- (optionally) Determine whether the provided display text is the correct display text for the code
- This is the main method for validating coded data!

Also available on CodeSystem

Example: \$validate-code

[GET /ValueSet/\\$validate-code?url=http://snomed.info/sct?fhir_vs&system=http://snomed.info/sct&code=38362002](http://localhost:8080/fhir/ValueSet/$validate-code?url=http://snomed.info/sct?fhir_vs&system=http://snomed.info/sct&code=38362002)

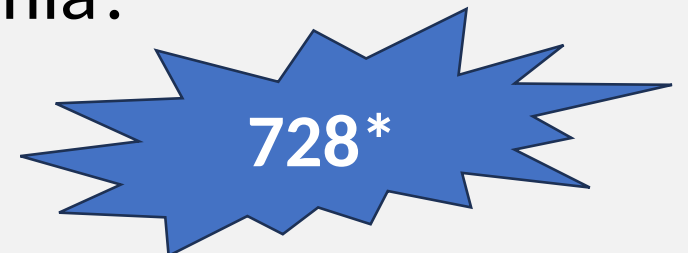
```
{
  "resourceType": "Parameters",
  "parameter": [
    {
      "name": "result",
      "valueBoolean": true
    },
    {
      "name": "display",
      "valueString": "Dengue fever"
    }
  ]
}
```

Example: \$validate-code with display

[GET /ValueSet/\\$validate-code?url=http://snomed.info/sct?fhir_vs&system=http://snomed.info/sct&code=13644009&display=hypercholesterolemia](http://snomed.info/sct?fhir_vs&system=http://snomed.info/sct&code=13644009&display=hypercholesterolemia)

```
{
  "resourceType": "Parameters",
  "parameter": [
    {
      "name": "result",
      "valueBoolean": false
    },
    {
      "name": "display",
      "valueString": "Hypercholesterolaemia"
    },
    {
      "name": "message",
      "valueString": "The code 13644009 exists in the ValueSet,
        but the display \"hypercholesterolemia\" is incorrect"
    }
  ]
}
```

How many ways can you spell hypercholesterolaemia?



728*

*analysis from free text data entry

Basic use cases – exploring a set of concepts

See how concepts relate to one another

- Use \$lookup to retrieve their properties
- Use \$expand with properties included in the expansion results
- Use the 'child' and 'parent' properties of \$lookup, or \$subsumes/\$closure, to explore the hierarchy that exists between concepts

<https://ontosever.csiro.au/shrimp>

The screenshot shows the Shrimp/SNOMED CT interface. The main area displays a concept hierarchy for 'Pneumococcal pneumonia'. The hierarchy starts with 'Pneumococcal pneumonia' at the top, which branches into 'Pneumococcal pneumonia associated with AIDS' and 'Pneumococcal pneumonia'. 'Pneumococcal pneumonia' further branches into 'Pneumococcal pneumonia associated with AIDS' and 'Pneumococcal pneumonia'. The 'Pneumococcal pneumonia' node is highlighted in blue. Below the hierarchy, there is a table with the following columns: PROPERTY and VALUE.

PROPERTY	VALUE
Code	233607000
Fully specified name	Pneumococcal pneumonia (disorder)
Preferred name	Pneumococcal pneumonia
Synonym	Pneumococcal pneumonia (disorder)
Effective Time	20150731
Primitive	false
Module ID	20000000000000000000

Example: \$lookup

GET /CodeSystem/\$lookup?system
=http://csiro.au/cs/au-jurisdictions&code
=WA

```

{
  "resourceType": "Parameters",
  "parameter": [
    {
      "name": "name",
      "valueString": "Australian jurisdictions"
    },
    {
      "name": "version",
      "valueString": "0.0.1"
    },
    {
      "name": "display",
      "valueString": "Western Australia"
    },
    {
      "name": "designation",
      "part": [
        {
          "name": "use",
          "valueCoding": {
            "system": "http://snomed.info/sct",
            "code": "9000000000000013009"
          }
        },
        {
          "name": "value",
          "valueString": "West Australia"
        }
      ]
    },
    {
      "name": "property",
      "part": [
        {
          "name": "code",
          "valueCode": "parent"
        },
        {
          "name": "value",
          "valueCode": "AU-state"
        }
      ]
    }
  ]
}

```

Example: \$subsumes

GET /CodeSystem/\$subsumes?
system=http://snomed.info/sct&
codeA=38866009&codeB=85562004

Body part structure

Hand structure

```
{
  "resourceType": "Parameters",
  "parameter": [
    {
      "name": "outcome",
      "valueCode": "subsumes"
    }
  ]
}
```

Basic use cases – translating between code systems

Always between codes in one ValueSet and codes in another in the context of a ConceptMap – **context matters**

Example uses might be

- mapping clinical codes to administrative codes for billing or reporting
- mapping legacy codes to replacement codes

Use \$translate

Example: \$translate

GET /Concept
 url=http://sn
 &target=http
 &system=htt
 &code=3991

```
{
  "resourceType": "Parameters",
  "parameter": [
    {
      "name": "result",
      "valueBoolean": true
    },
    {
      "name": "match",
      "part": [
        {
          "name": "equivalence",
          "valueCode": "equivalent"
        },
        {
          "name": "concept",
          "valueCoding": {
            "system": "http://snomed.info/sct",
            "code": "1046151000168100",
            "display": "Diabetes mellitus co-occurrent and due to haemochromatosis"
          }
        }
      ]
    },
    {
      "name": "source",
      "valueString": "http://snomed.info/sct/32506021000036107/version/20190531?fhir_cm=900000000000526001"
    }
  ]
}
```

Special implicit maps in SNOMED CT for inactive concepts

Basic use cases – categorising coded data

Use `$translate` to map ‘foreign’ coded data into a normalized CodeSystem/ValueSet for analysis

Use `$translate` to map coded data into coded categories

Use `$subsumes` / `$closure`, or `$validate-code` a ValueSet to categorise data

Global adoption

FHIR Terminology Services – the de-facto standard terminology API, not just for FHIR

Growth of National Terminology Services – US, Canada, Netherlands, UK, Australia, New Zealand...

- Key to FHIR base and core implementation guides for national/international interoperability

Reduces Burden on Developers and Organizations

- Common set of terminologies and coding standards maintained and available to pick up and use

Global Collaboration and Harmonization

- Alignment of standards facilitates cross-border data exchange and integration

Adoption in Healthcare Systems

- Integration into EHRs, decision support, and health information exchanges
- Enhances data quality, consistency, and sharing

Opportunities for Interoperability and Analytics

- Seamless data exchange and consistent data representation for effective analysis and research

Where to find out more...

- The FHIR Specification
 - <https://www.hl7.org/fhir/terminology-service.html>
- FHIR Terminology Service launchpad
 - <https://ontoserver.csiro.au/site/technical-documentation/ontoserver-technical-documentation/fhir-launchpad/>
- Working examples in Ontoserver's Postman Collection

▶ Run in Postman

What have we covered?

1. The basics of the FHIR Terminology Service

- What the FHIR Terminology Services is, its value and role.

2. Key Resources and Operations

- Main resources: CodeSystems, ValueSets, ConceptMaps.
- Primary operations: \$lookup, \$expand, \$validate-code, \$translate.

3. Practical Use Cases

- Use CodeSystems, ValueSets, and ConceptMaps in data capture, validation, analytics/reporting...

4. The Benefits

- Increased efficiency, consistency, easier maintenance, enhanced interoperability.

5. Global Adoption and Opportunities

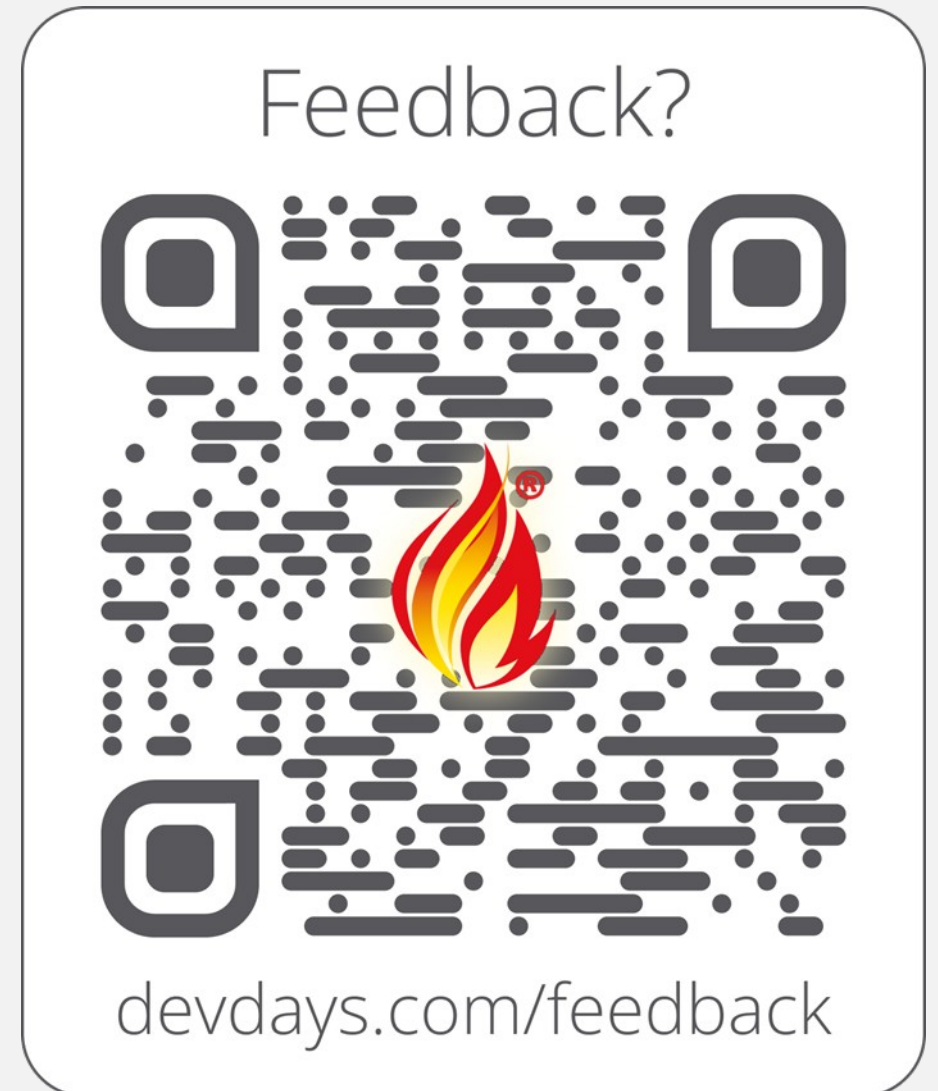
- National and global terminology services are here and growing, and offer a great advantage to those who can make use of them.

6. Leverage Resources and Tools

- Be aware of additional resources and tools for deeper understanding and implementation.

Contact

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