IVC Training

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THURSDAY, MAY 8, 2025

BORDEAUX FRANCE

Big Picture & Importance of Vocabulary

International Vaccine Codes

American Tourist in Japan

International Vaccine Codes

小麦粉

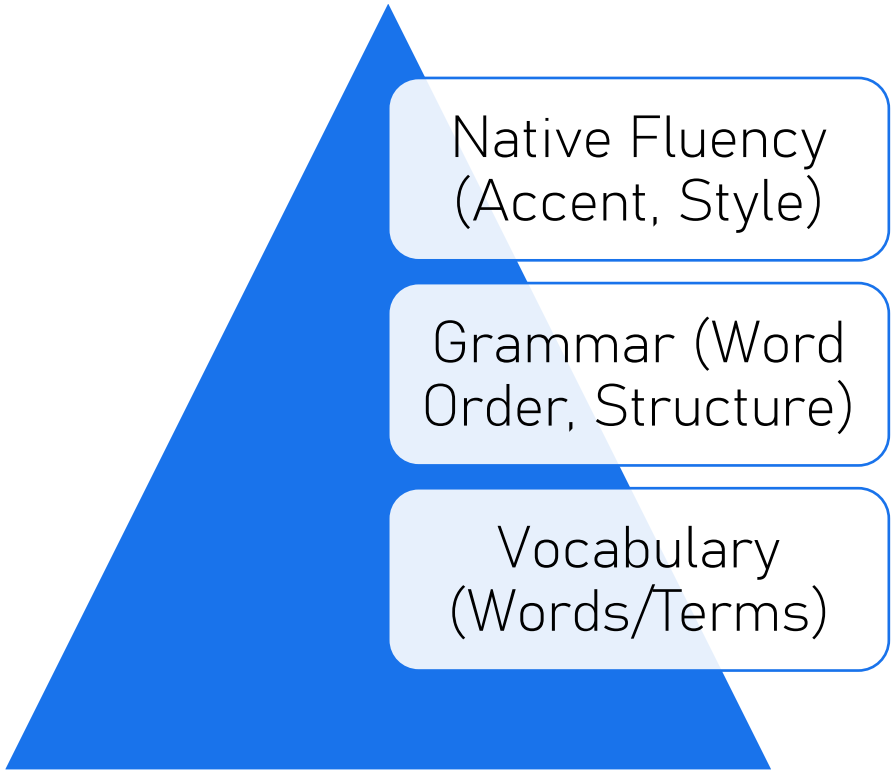
Komugiko

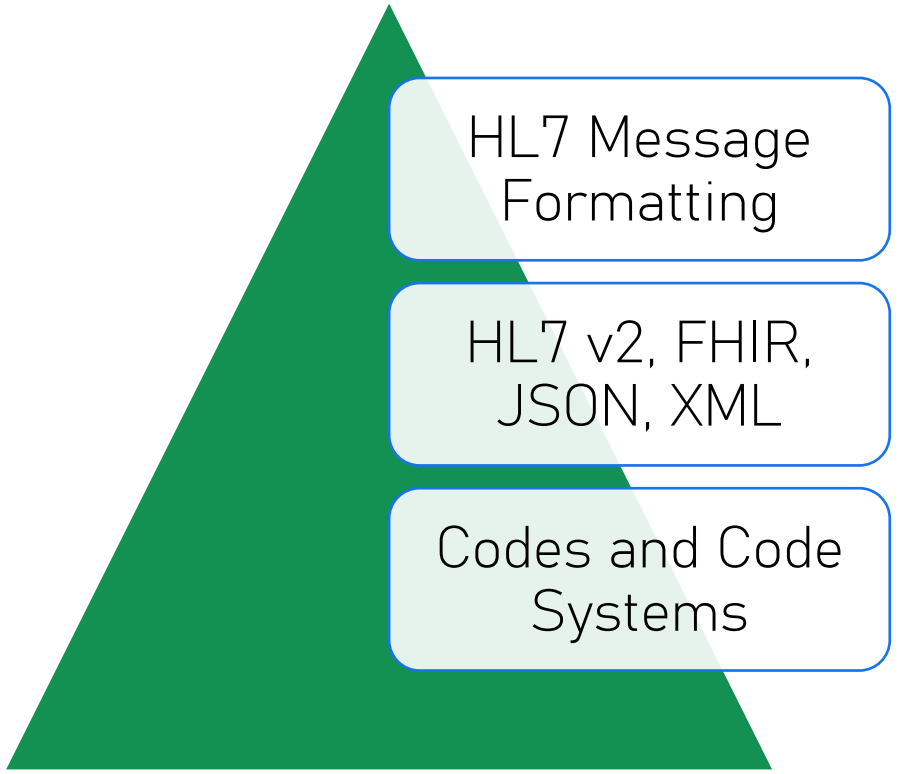
International Vaccine Codes

Please, dear sir, can you be so kind as to help direct me to the _____ ?

International Vaccine Codes

Vocabulary vs Grammar – Communication Hierarchy



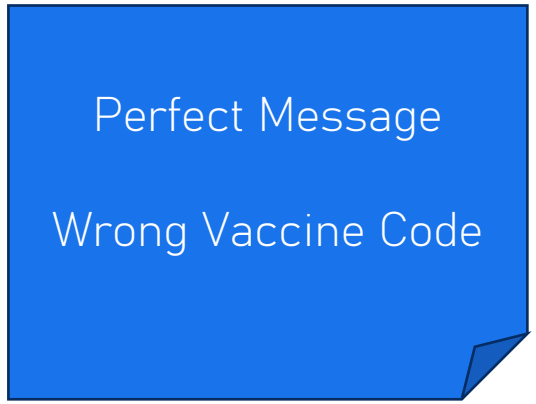


International Vaccine Codes

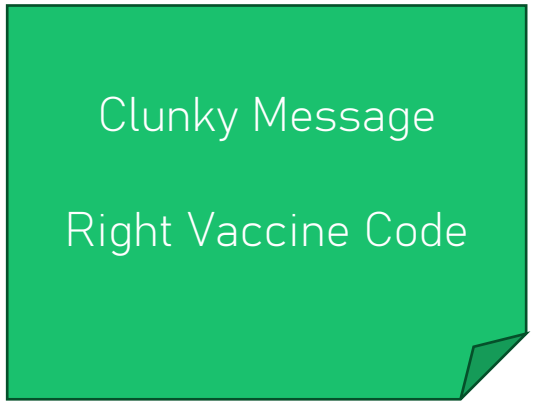
In health data, just like in language, structure is helpful. But the **words** you use carry the actual meaning. If the word is wrong, the structure can't save you.

In Health Data Exchange, Vocabulary = Meaning

- Vocabulary ≠ "labels"—they are deeply coded and governed concepts.
- HL7/FHIR don't define meaning — they define structure.
- Meaning travels in code systems, value sets, and the vocabulary chosen.



Failure



Usable

International Vaccine Codes

Most Data Quality Problems = Vocabulary Problems

- Most communication complexity lives in definitions, not format.
- Grammar and structure can't make up for wrong or unclear vocabulary.
- Most real-world data validation work focuses on ensuring correct vocabulary, not messaging syntax.

International Vaccine Codes

Vocabulary is the Core of Interoperability

- Codes = Meaning
  - They carry all the clinical relevance.
- Structure Helps, Vocabulary Enables
  - HL7/FHIR can carry any code; only good codes carry good data.
- Your Message Is Only as Good as Its Vocabulary
  - This is why coding is at the heart of public health data quality.

komugiko, *harina*, *farine*, *flour*

International Vaccine Codes

Vocabulary in Health Data Exchange

Place, Language, and Vocabulary

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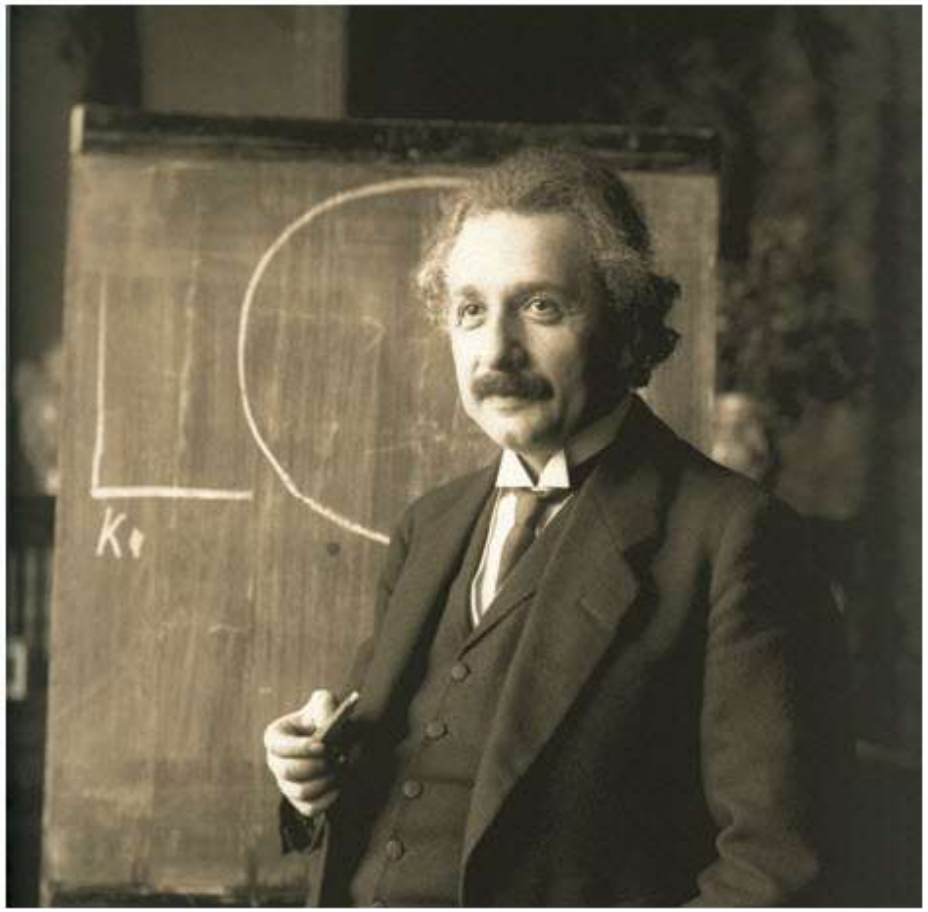
Communication Needs Three Things

- Interested in $E = mc^2$?
- Want to talk to Einstein?
- What is needed to communicate?



International Vaccine Codes

Place

TARDIS

Zurich Park Bench in 1905

International Vaccine Codes

Language

- Sprechen Sie Duetsch?

Einstein's 1905 Paper
On the Electrodynamics of Moving bodies

3. *Zur Elektrodynamik bewegter Körper;*
von A. Einstein.

Daß die Elektrodynamik Maxwells — wie dieselbe gegenwärtig aufgefaßt zu werden pflegt — in ihrer Anwendung auf bewegte Körper zu Asymmetrien führt, welche den Phänomenen nicht anzuhaften scheinen, ist bekannt. Man denke z. B. an die elektrodynamische Wechselwirkung zwischen einem Magneten und einem Leiter. Das beobachtbare Phänomen hängt hier nur ab von der Relativbewegung von Leiter und Magnet, während nach der üblichen Auffassung die beiden Fälle, daß der eine oder der andere dieser Körper der bewegte sei, streng voneinander zu trennen sind. Bewegt sich nämlich der Magnet und ruht der Leiter, so entsteht in der Umgebung des Magneten ein elektrisches Feld von gewissem Energiewerte, welches an

International Vaccine Codes

Vocabulary

- Elektrodynamik Maxwells
- Körper
- Phänomen
- Wechselwirkung

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International Vaccine Codes

Vocabulary

- Elektrodynamik Maxwells
  - Maxwells Electrodynamics
- Körper
  - Body
- Phänomen
  - Phenomenon
- Wechselwirkung
  - Interaction

Einstein's 1905 Paper
On the Electrodynamics of Moving bodies

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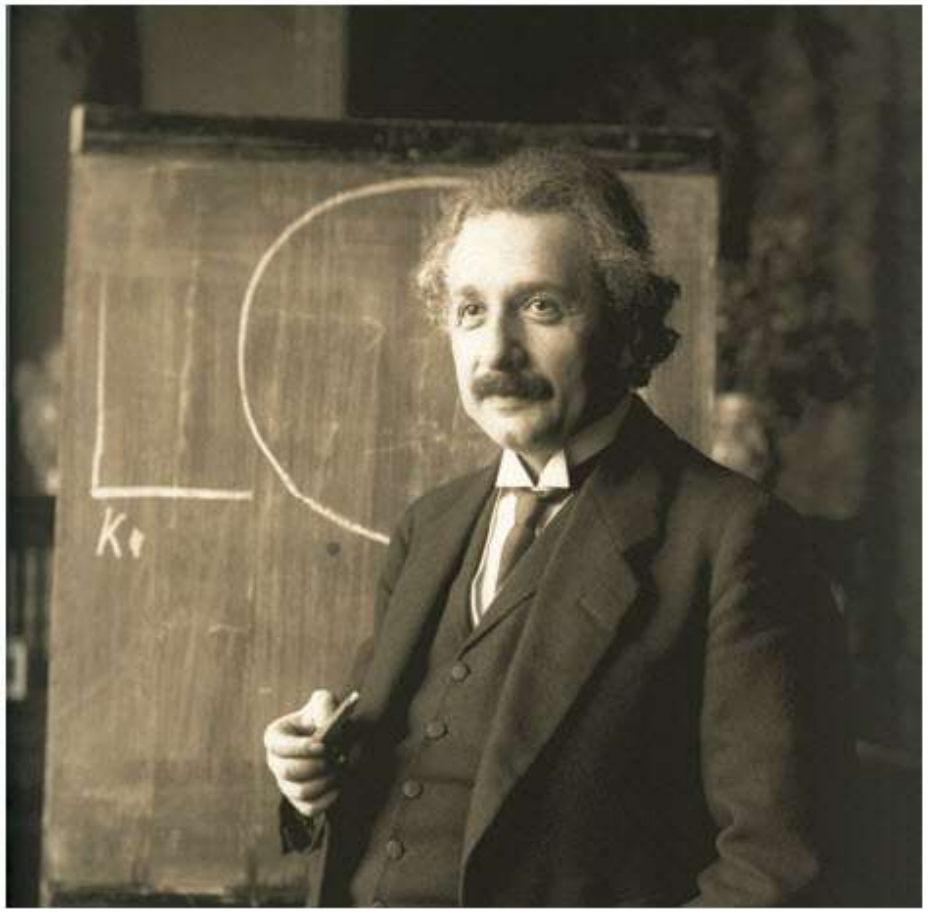
International Vaccine Codes

Communication Needs Three Things

- Place
- Language
- Vocabulary



International Vaccine Codes

Communication Needs Three Things

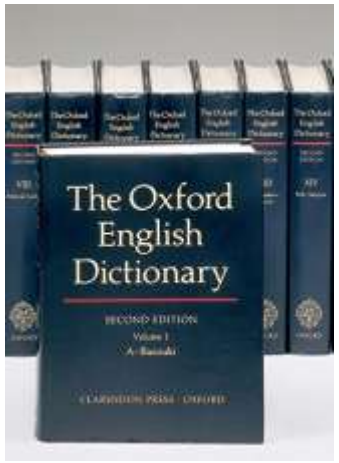
- Place
- Language
- Vocabulary

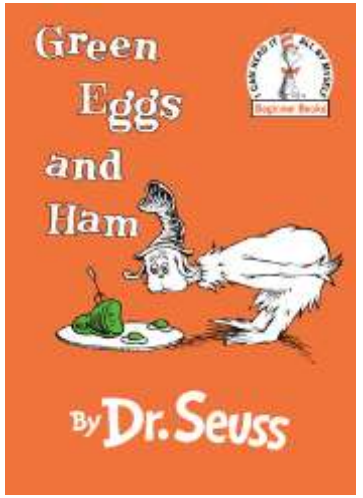
- Secure Transport
- HL7 v2, FHIR, JSON, XML, flat file, etc.
- SNOMED-CT, CVX, CPT, ATC, ICD-11, CVC

International Vaccine Codes

Key Vocabulary Concepts in Health Data

- Code System
  - The dictionary (e.g., CVX, SNOMED, ICD)
- Code
  - A single word or entry (e.g., CVX 10 = Polio)
- Value Set
  - A curated list for one specific purpose (e.g., all routine childhood vaccines)

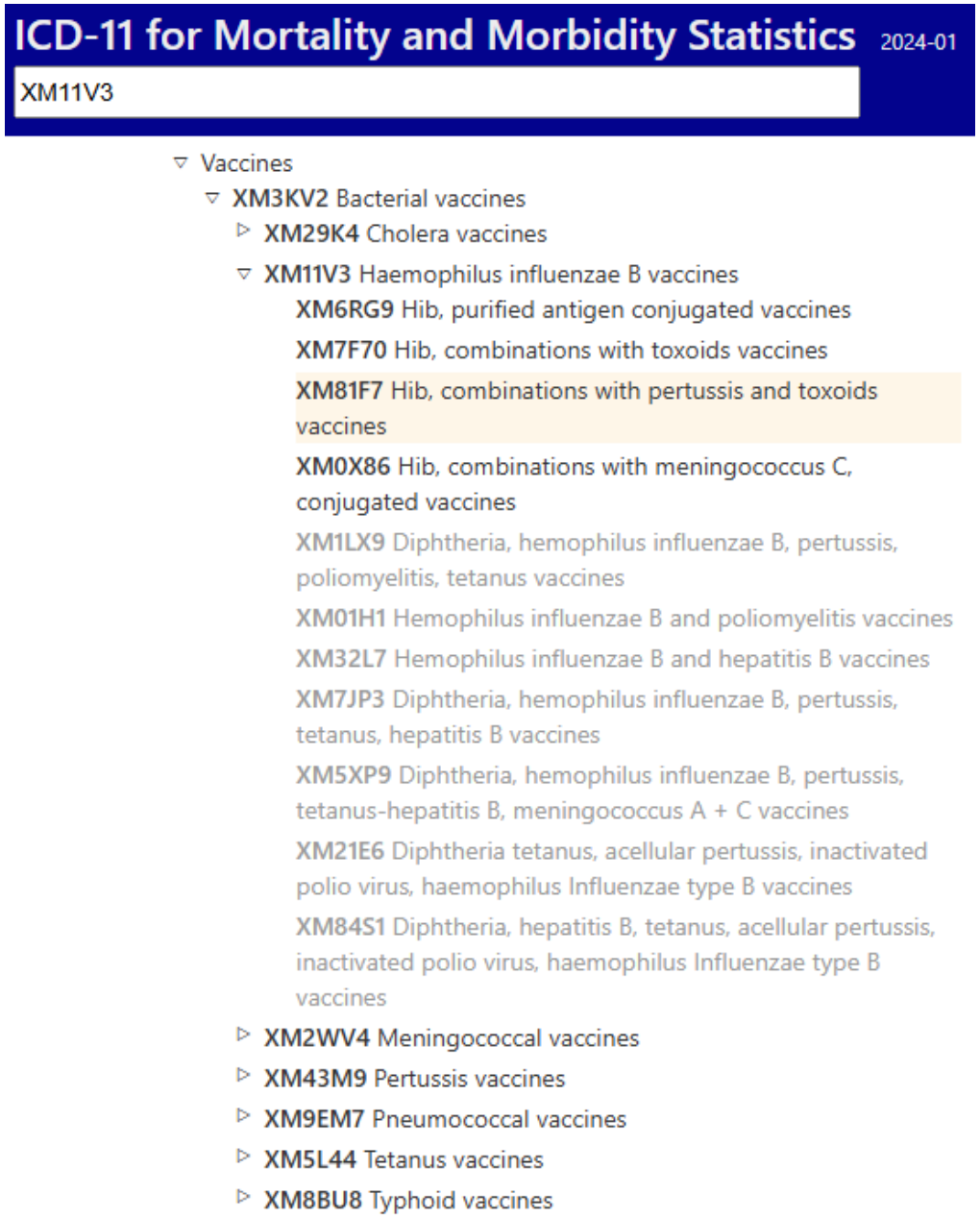




International Vaccine Codes

ICD-11 Example

- ICD-11
  - 17 000 unique codes
- You would not use all the terms for a specific use case
  - Imagine a 17 000 items on a drop down!
- Arranged in a hierarchy



International Vaccine Codes

CVX Example

- Use a subset based on use case
  - Recording newly administered vaccinations
  - Recording historical vaccinations
  - VIS statements

Short Description	Full Vaccine name	CVX Code	Vaccine Status	Last Updated Date	Notes
Adenovirus types 4 and 7	Adenovirus, type 4 and type 7, live, oral	143	Active	3/20/2011	This vaccine is administered as 2 tablets.
Adenovirus types 4 and 7	Adenovirus, type 4 and type 7, live, oral	143	Active	3/20/2011	This vaccine is administered as 2 tablets.
adenovirus, type 4	adenovirus vaccine, type 4, live, oral	54	Inactive	5/28/2010	
adenovirus, type 4	adenovirus vaccine, type 4, live, oral	54	Inactive	5/28/2010	
adenovirus, type 7	adenovirus vaccine, type 7, live, oral	55	Inactive	5/28/2010	
adenovirus, type 7	adenovirus vaccine, type 7, live, oral	55	Inactive	5/28/2010	
adenovirus, unspecified formulation	adenovirus vaccine, unspecified formulation	82	Inactive	9/30/2010	This CVX code allows reporting of a vaccination when formulation is unknown (for example, when recording a adenovirus vaccination when noted on a vaccination card)

International Vaccine Codes

HL7 v2 Supports Multiple Codes for One Concept

Table 4-2 Coded Element (CE)

SEQ	Component Name	Data Type	Usage	LEN	Conditional Predicate	Value Set	Comments
1	Identifier	ST	R	1..50			Identifying Code.
2	Text	ST	RE	1..999			Human readable text that is not further used.
3	Name of Coding System	ID	R	1..20		HL70396	
4	Alternate Identifier	ST	RE	1..50			Alternate Identifying code.
5	Alternate Text	ST	C(RE/X)	1..999	If CE-4 (Alternate Identifier) is valued		Human readable text that is not further used.
6	Name of Alternate Coding system	ID	C(R/X)	1..20	If CE-4 (Alternate Identifier) is valued	HL70396	

International Vaccine Codes

Vaccination Fields in HL7 v2

```
ORC|RE||2982^NDA|||||||1121^Medina^Laura||^Jack^Randall^E^^^MD^^CMS^^^^NPI
```

CVX Code | NDC Code

```
RXA|0|1|20171130|20171130|115^Tdap^CVX^58160-0842-52^^NDC|0.5|mL^^UCUM|

    |00^New immunization record^ NIP001|^Medina^Laura^^^^^^|^^^NV1234||||T975M|20180415|
```

Manufacturer

```
    SKB^GlaxoSmithKline^MVX|||CP|A|
```

Route | Site

```
RXR|IM^Intramuscular^HL70162|LD^Left Deltoid^HL70163
```

International Vaccine Codes

FHIR: Repeatable Codings with Clear Systems

- Uses as a “URL”
  - Not to be used in a browser
  - Meant to be universally unique
- Just like HL7 v2, more than one can be sent at a time

```json
"vaccineCode": {
  "coding": [
    { "system": "http://hl7.org/fhir/sid/cvx", "code": "10", "display": "Polio" },
    { "system": "http://example.org/local", "code": "POL123", "display": "Polio (Local)" }
  ]
}
```

International Vaccine Codes

No Matter the Format, Vocabulary Carries the Meaning

- Code sets are more foundational and last longer than interoperability formats
- CVX example
  - Created in 1990s for flat file and floppy disks
  - Reused in 2000s for HL7 v2 via the “web”
  - Reused again in 2020s for FHIR

International Vaccine Codes

The Challenge of Coding Systems

International Vaccine Codes

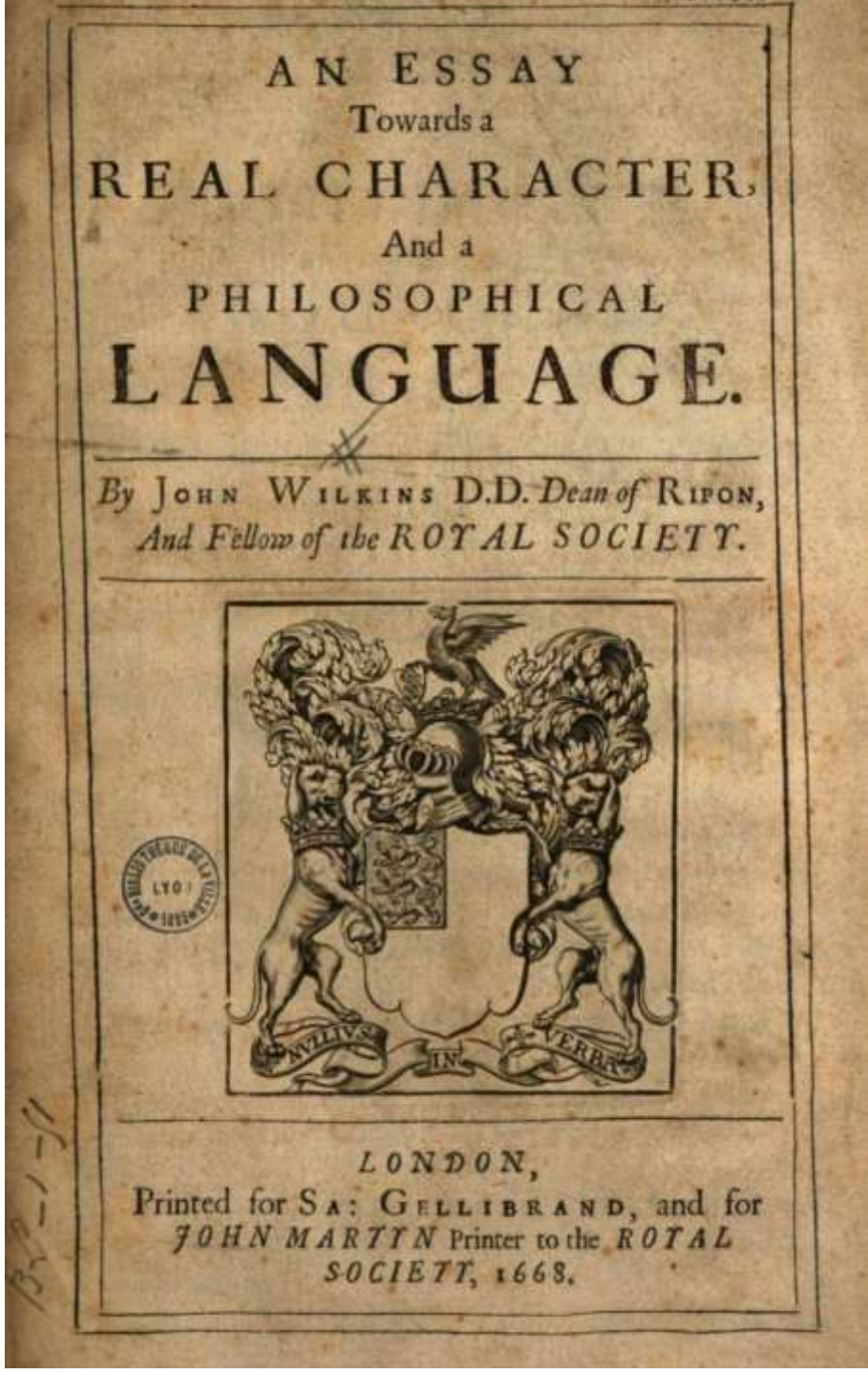
The Challenge of Vocabulary: Classifying the World with Words

- Why we can't have just one code system for everything
- Why code systems are never complete, and always changing
- Why code systems can be both too specific and too generic

International Vaccine Codes

One Code System for All

- John Wilkins created a “Philosophical Language”
  - Perfectly logical language
  - Classify everything in the universe into a hierarchical tree of concepts



International Vaccine Codes

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Zi
Beasts

Zit
Canine

Zip
Feline

Zita
Dog

Zipa
Lion

Zipi
Cat

International Vaccine Codes

One Code System for All

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- Required John to
  - First understand the structure of everything that exists
  - Including biology, chemistry, behavior, society
  - Even things not yet discovered

International Vaccine Codes

One Code System for All

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"The impossibility of penetrating the divine scheme of the universe cannot dissuade us from planning human schemes, even though we are aware they must be provisional." – Borges

Zi
Beasts

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International Vaccine Codes

If only they would stop inventing vaccines…

- The world of vaccines is always changing
  - New diseases
  - New platforms
  - New combinations
- Rate of change is increasing
- Need to adapt to new diseases is increasing
- We must work keep vaccine code sets up-to-date

International Vaccine Codes

Which is better:
To be more general or more specific?

- General Terms
  - Communication is fast and broad
- Specific Terms
  - Necessary for detail
  - Risks fragmentation
- We need layers of vocabulary
  - General (e.g., “MMR”)
  - Specific (e.g., “MMR, high dose, with adjuvant, from GSK, 10-pack”)

International Vaccine Codes

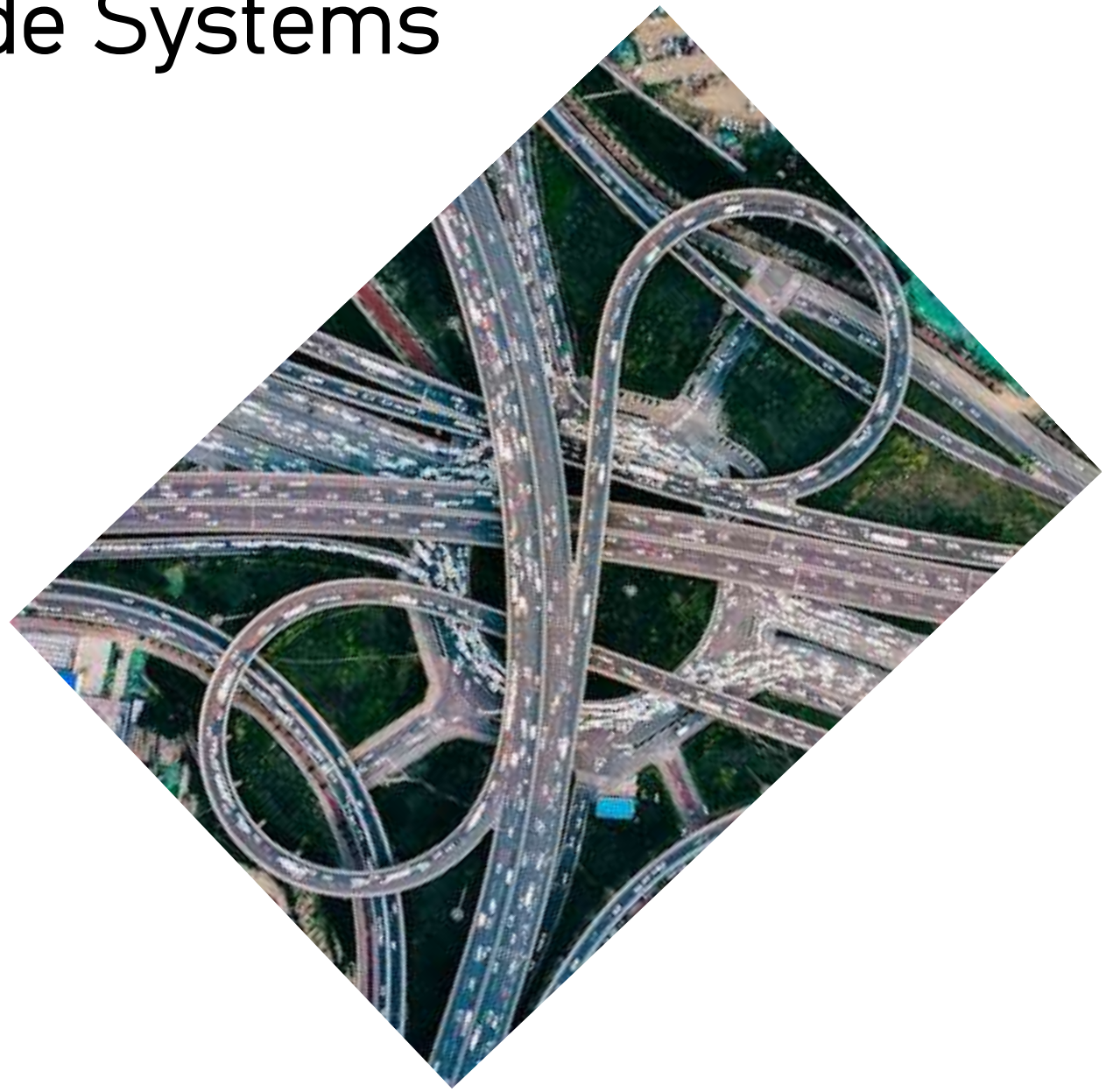
Vaccination Code Systems

CVX, MVX, NDC, SNOMED, LOINC, ICD, CPT

International Vaccine Codes

Commonly Vaccine Code Systems

- SNOMED-CT
- ICD-11
- ATC
- United States
  - CVX
  - MVX
  - NDC
- Canada
  - CVC
- NUVA



International Vaccine Codes

What is SNOMED CT?

SNOMED CT is a system of clinical codes that permit documentation of health information in a structured and standardized manner.

- A complete and detailed code system that covers diseases, procedures, symptoms, vaccines, and more
- Each SNOMED code represents a unique concept, with a specific clinical meaning
- In practice, always use a subset
  - Never use all of SNOMED, but subsets of values for specific reasons
  - For example: subset of all vaccine codes

International Vaccine Codes

SNOMED CT in Context

Where is SNOMED used?

- Electronic Health Record (EHR) systems
  - Standardized documentation
- Public Health information systems
  - Interoperability and tracking
- DHIS2
  - Classification and reporting clinical data

International Vaccine Codes

SNOMED-CT

- Objective

  Translate notes, clinical concepts into codified values

- Structure

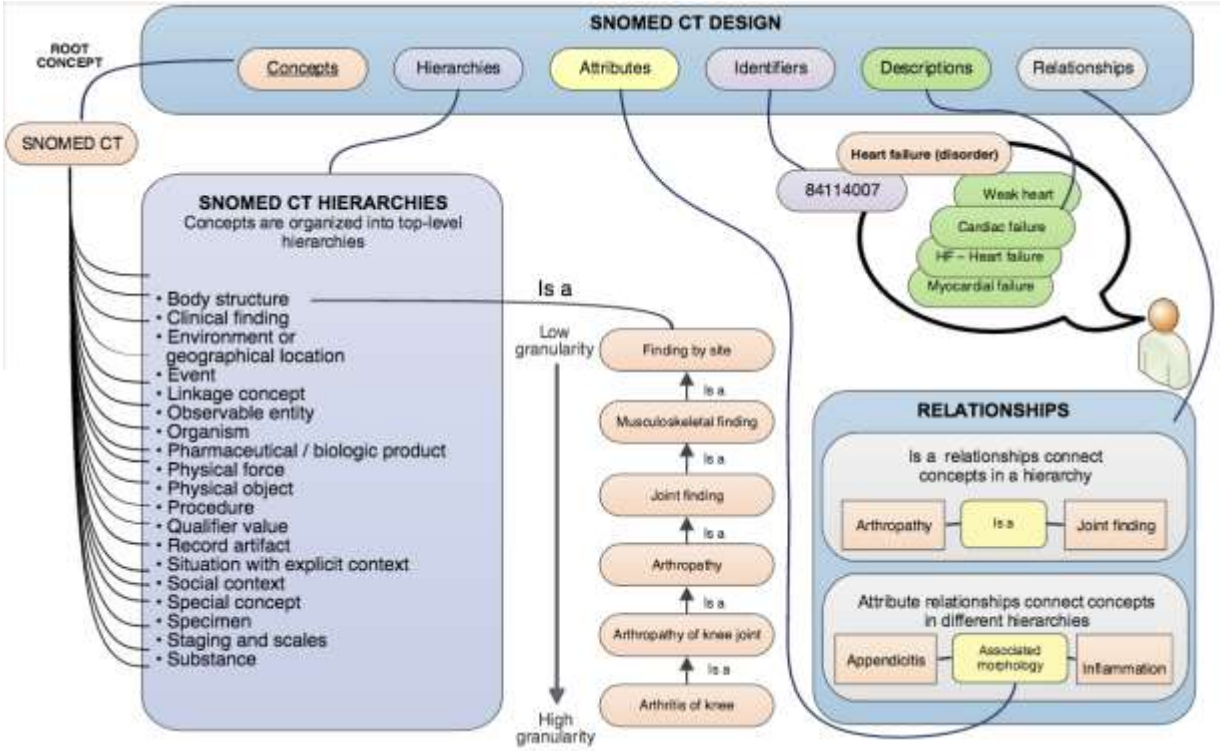
  Codes are organized into hierarchies from generic to specific concepts

- Licensing

  In general, it requires a license to use, some countries have their own codes for vaccines

- Community Set

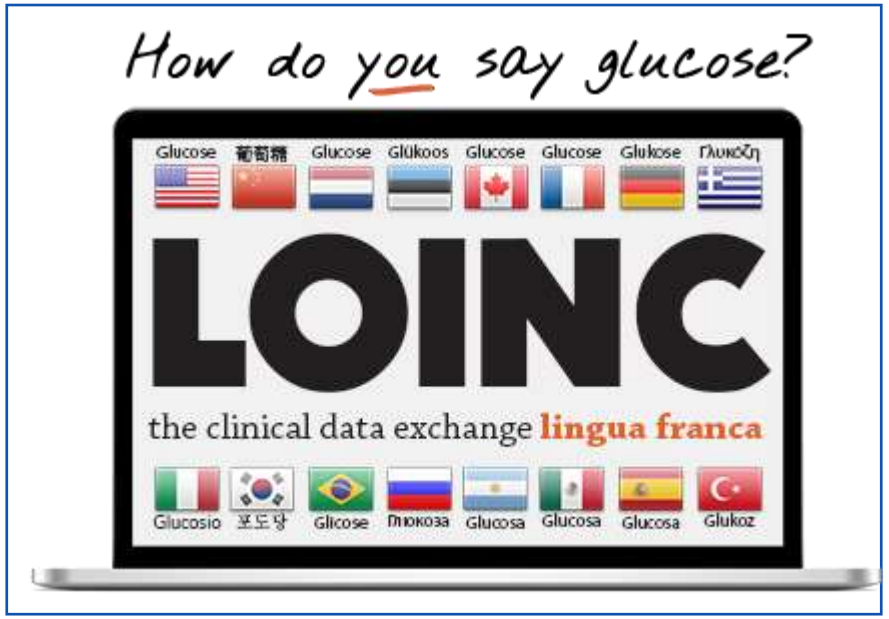
  Includes generic vaccine concepts



International Vaccine Codes

Vocabulary – LOINC

- Logical Observation Identifier Names and Codes
  - A universal code system for test, measurements, and observations
  - Created by Regenstrief Institute
  - http://loinc.org/
  - Free to use
- Used in
  - HL7 v2
  - HL7 v3
  - HL7 FHIR



International Vaccine Codes

ICD-11: International Classification of Diseases

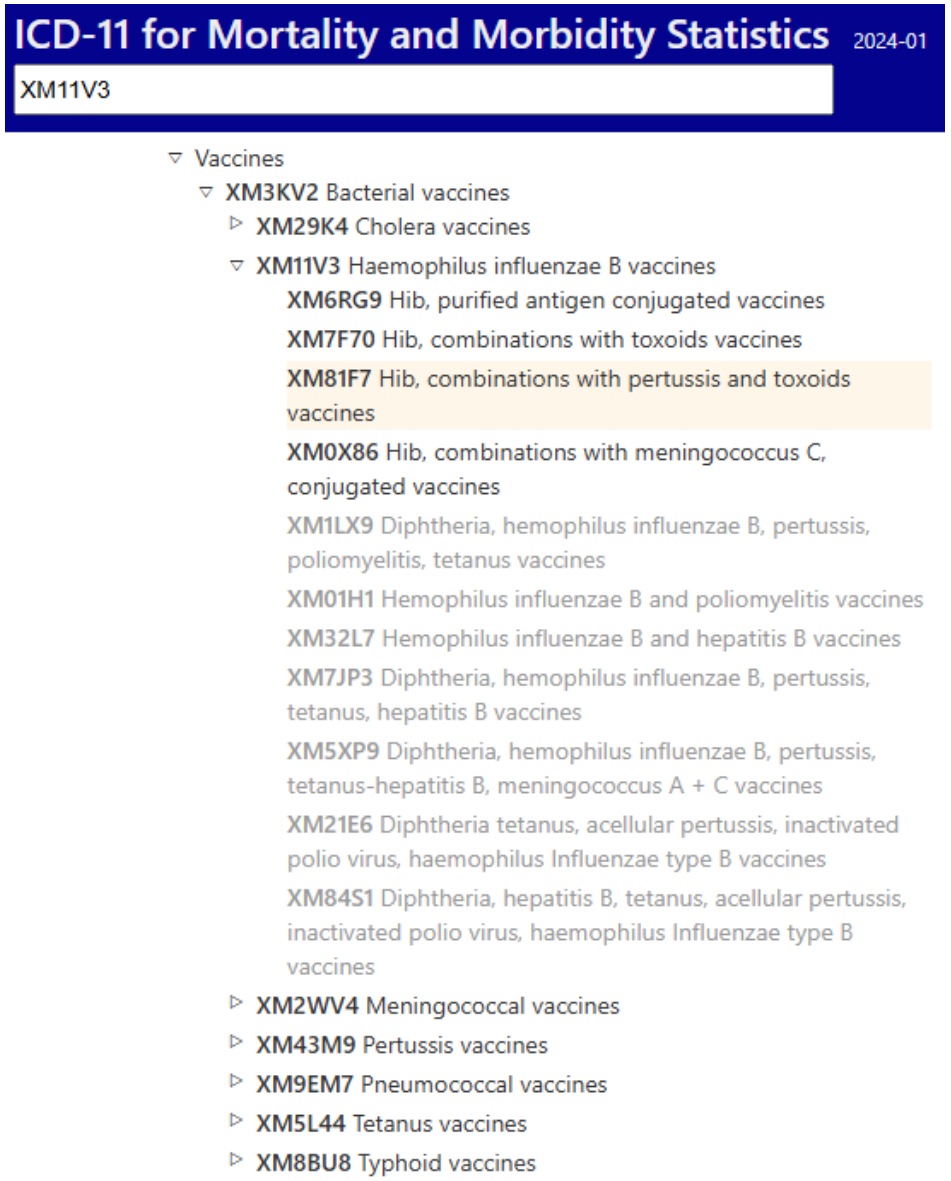
- Maintained by

  World Health Organization

- Purpose

  Describe diagnostic health information Vaccinations

  Contains generic codes to record events related to vaccinations



International Vaccine Codes

Anatomical Therapeutic Chemical (ATC)

- Maintained by

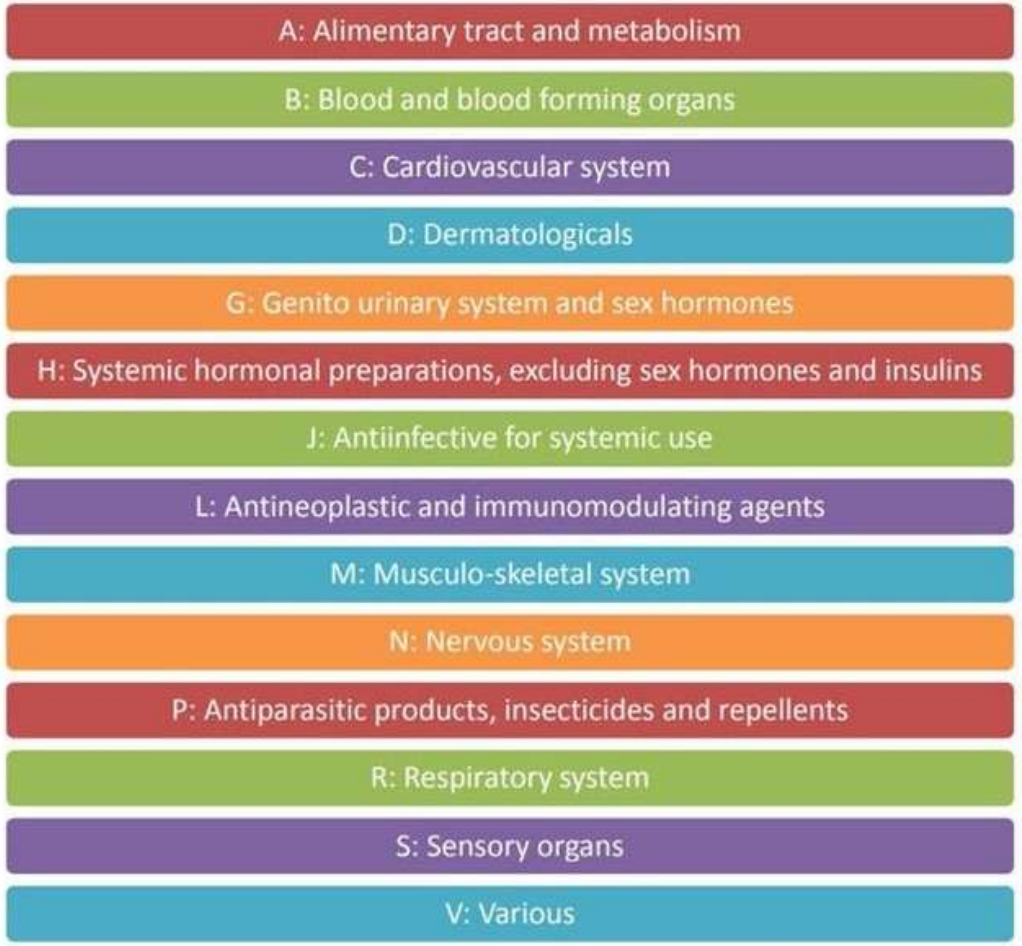
  World Health Organization (WHO)

- Purpose

  Classify groups of products with similar characteristics

- Focus

  Does not describe specific products, but rather classes of products

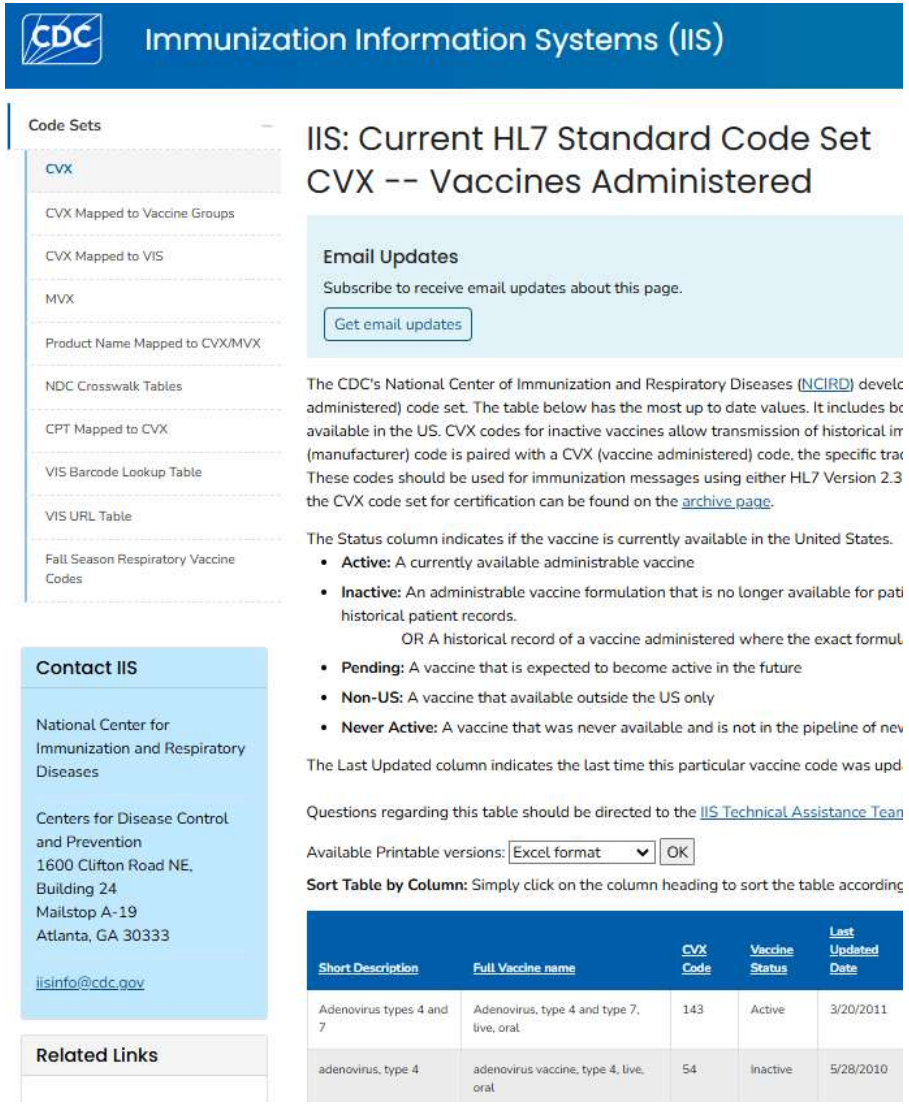


C ----------Cardiovascular system
C08----------Calcium channel blockers
C08D----------Selective calcium channel blockers with direct cardiac effects
C08DA----------Phenylalkylamine derivatives
C08DA01--------Verapamil

International Vaccine Codes

United States: CVX, MVX, NDC

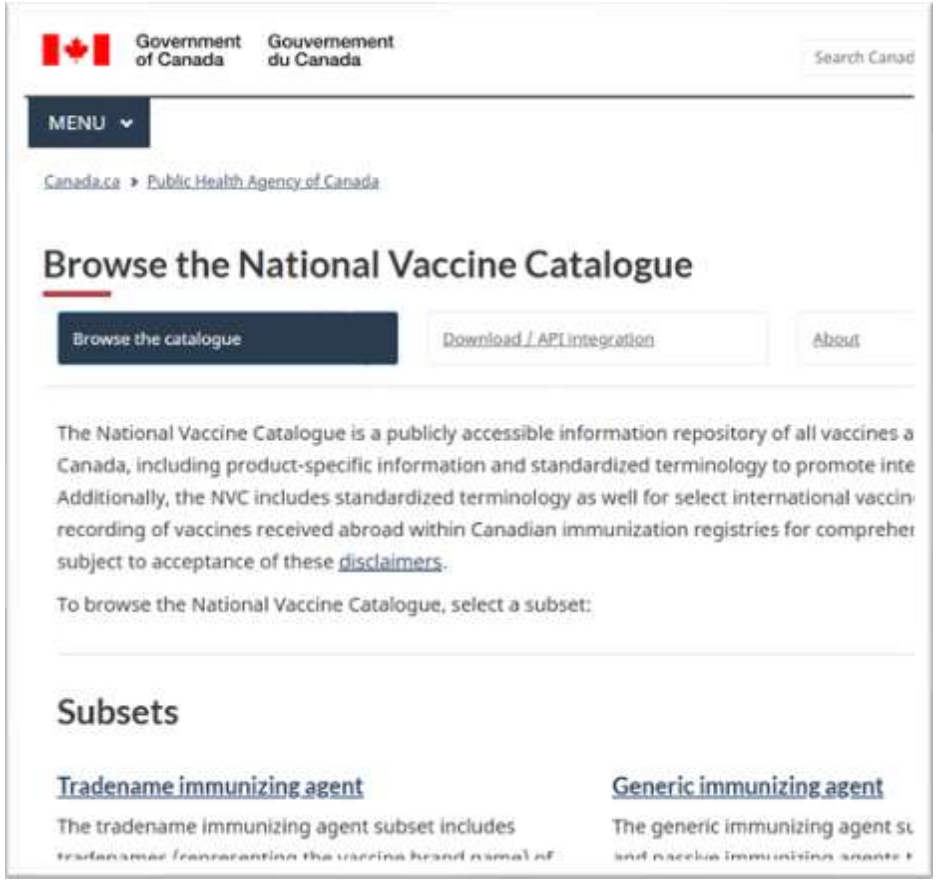
- CVX – Vaccination
  - Describes vaccines as part of vaccination history
  - Includes generic and specific codes
  - Used also outside the U.S. in various standards
- MVX – Manufacturer
- NDC – National Drug Code
  - Identifies products and specific vaccines
  - Used to support inventory functions
- CPT – Current Procedural Terminology
  - American Medical Association (AMA)



International Vaccine Codes

Canadian Vaccine Catalogue: CVC

- CVC
  - Code for vaccinations
- Strength
  - Very detailed and mature
- Use
  - Optimized for the Canadian health system



International Vaccine Codes

NUVA: Unified Nomenclature for Vaccines

- Purpose
  - Represent all vaccine concepts
  - Support mapping between NUVA and other code systems
- International Collaboration
  - By working with multiple code systems, NUVA supports global interoperability
- Goal
  - Simplify and standardize the use of vaccine codes in different contexts

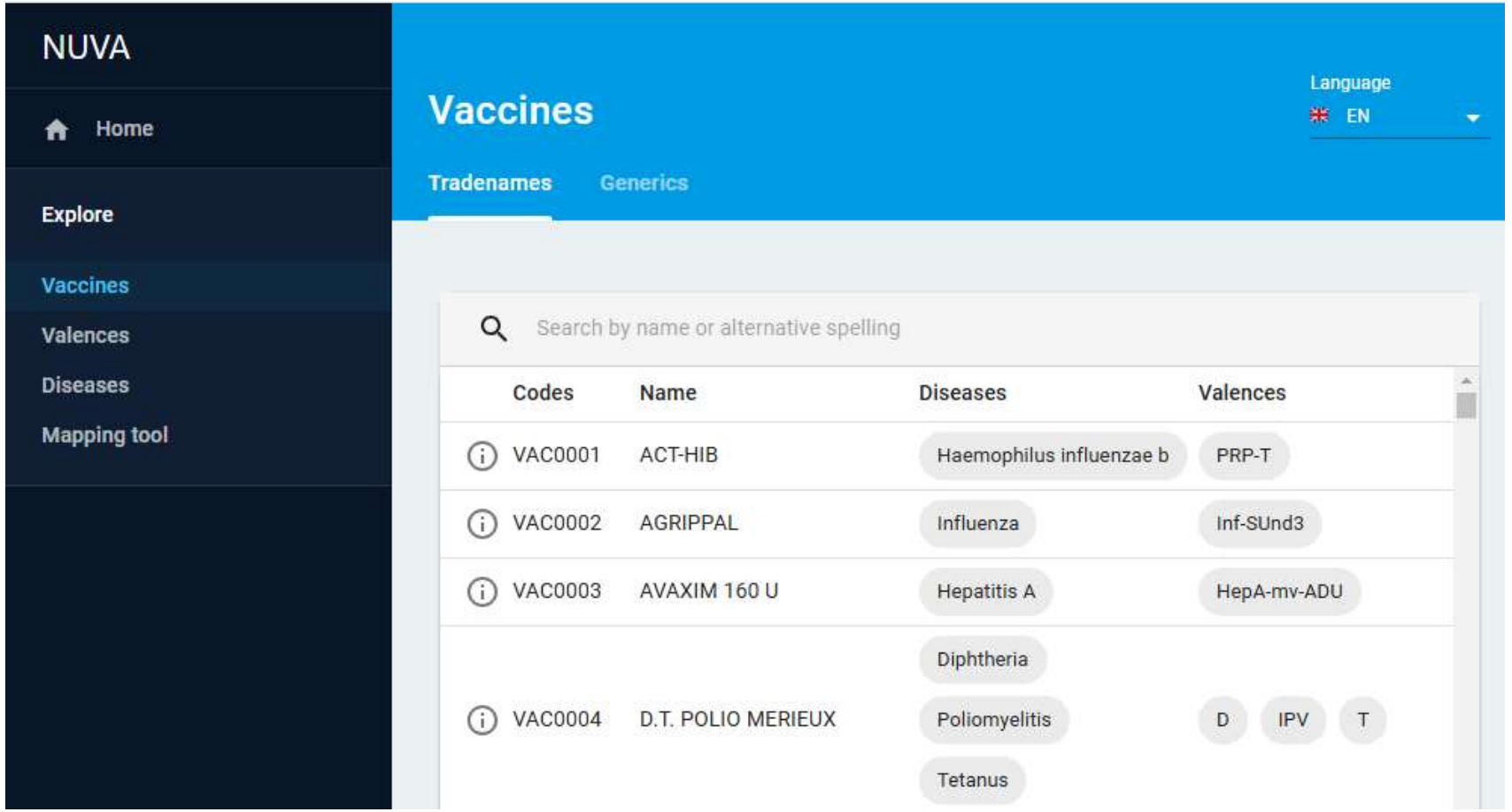
International Vaccine Codes

NUVA: Unified Nomenclature for Vaccines

- What does it do?
  - Documents complete vaccination histories
  - For any vaccination, given in any part of the world, at any time in the past
    - Up to 120 years ago, in any country, to any person
  - The objective is to establish if the patient is protected
    - Support patient personally
    - Support public health monitoring generally
- What does it not do?
  - Directly support manufacturing, market authorization, distribution, payment, or tracking ingredients
- What is a valence?
  - Describes the functions that a vaccine performs to protect patient
  - Key to mapping NUVA terms to other code systems

International Vaccine Codes

NUVA: Unified Nomenclature for Vaccines



International Vaccine Codes

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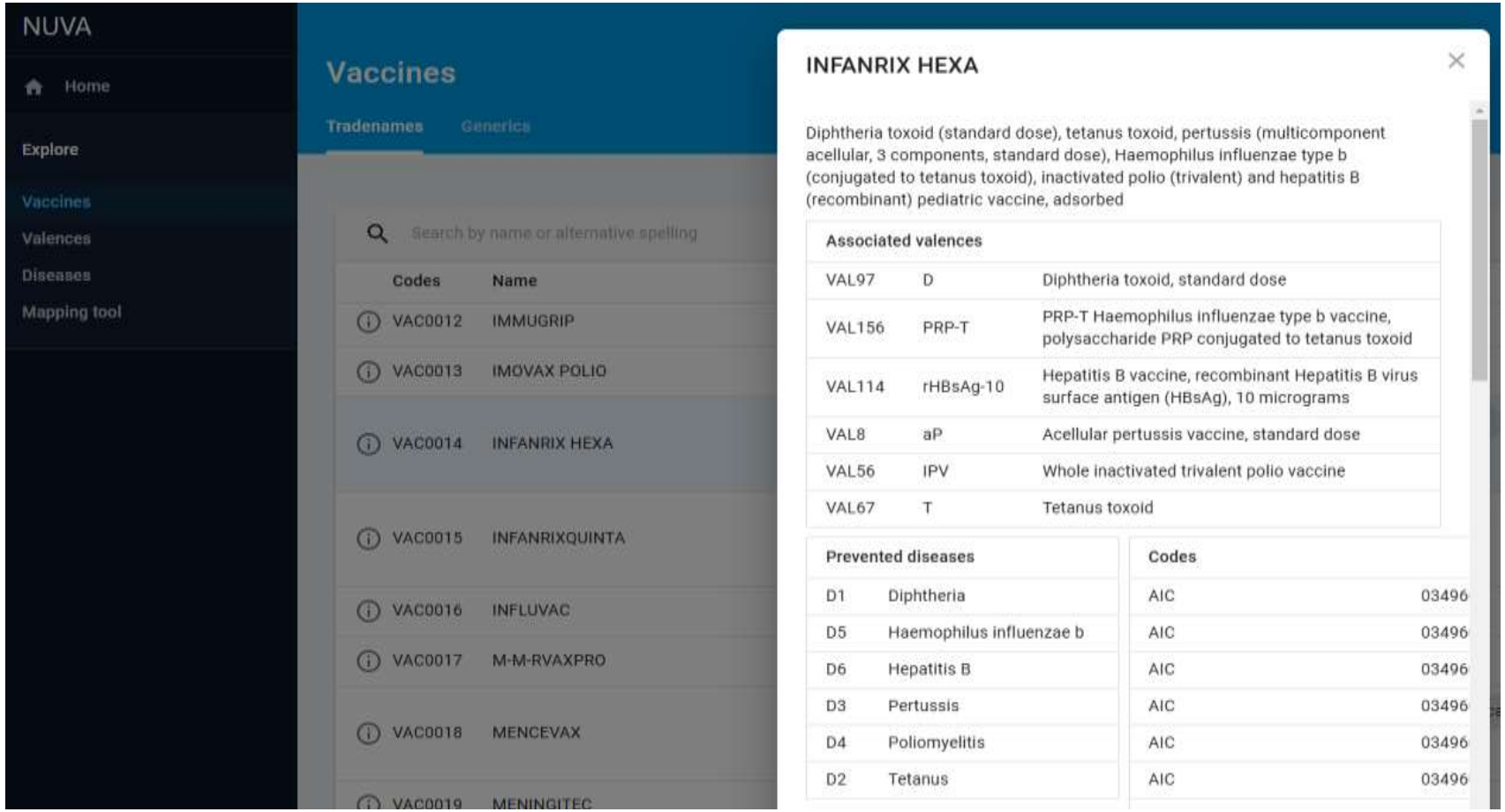

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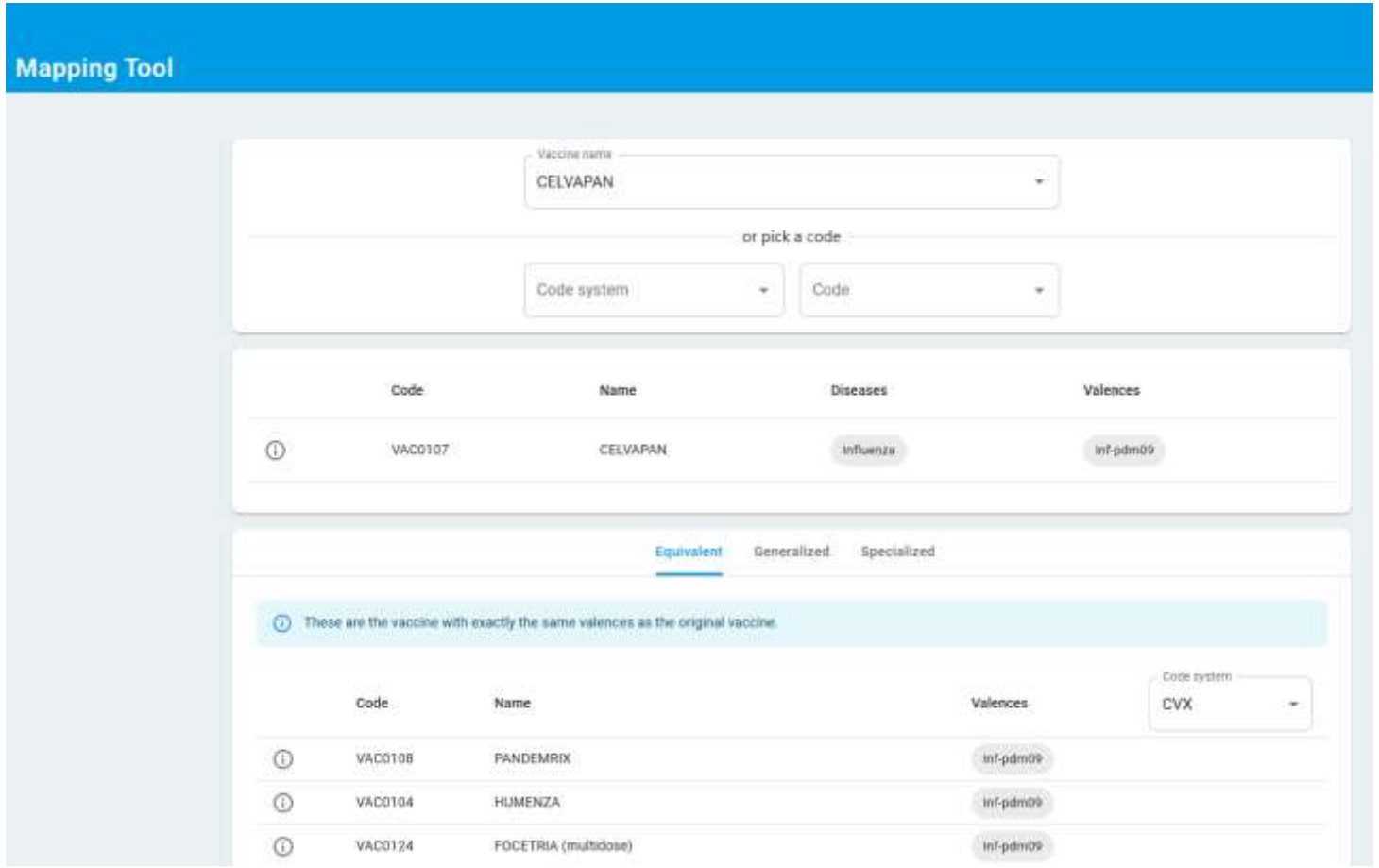


International Vaccine Codes

Conclusion

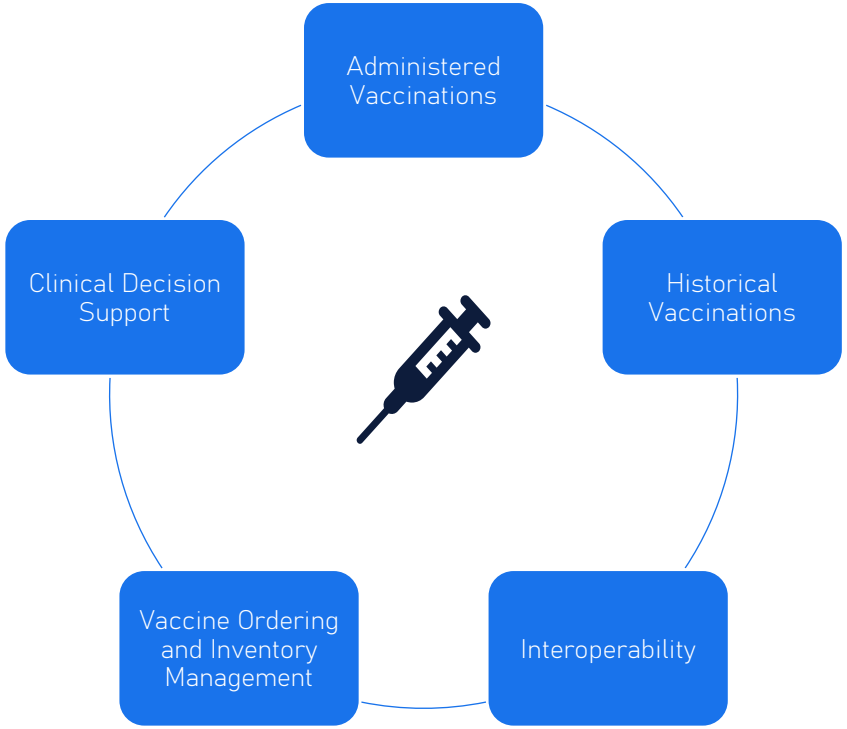
- Codes are critical
- There are many vaccine code systems in use
- We are creating IVC to help navigate these systems and help all of our projects
- NUVA is a resource that you can use today

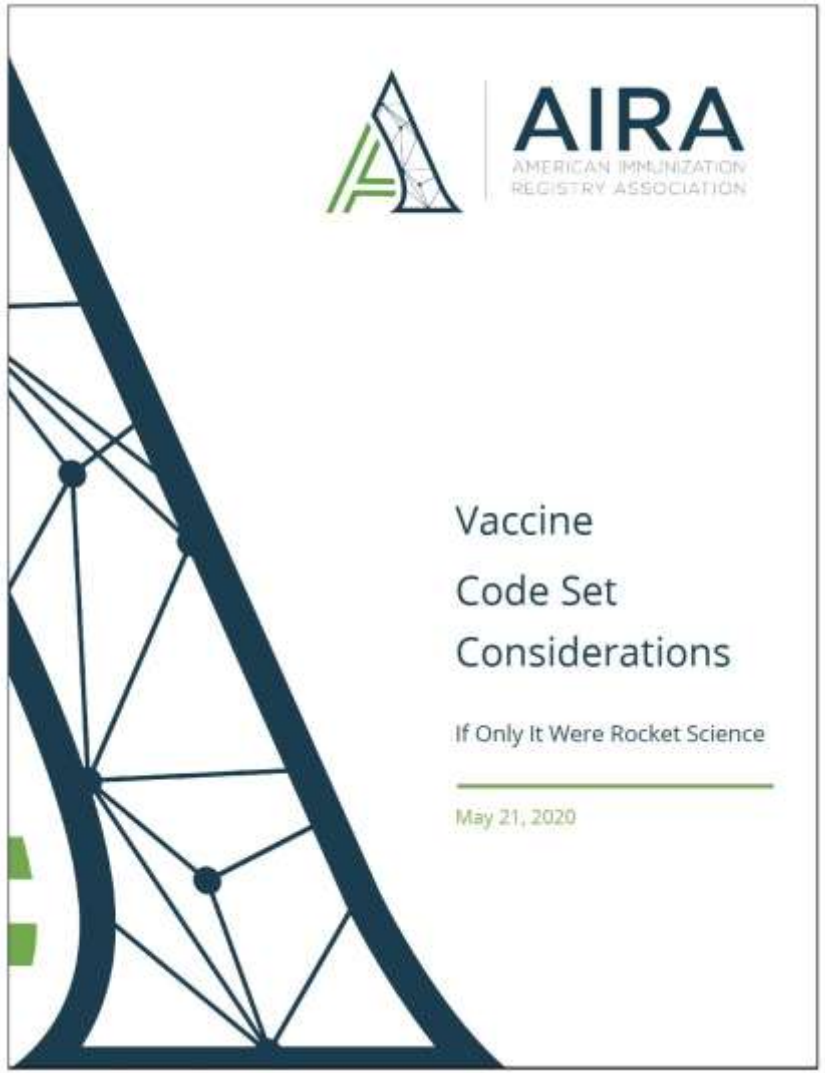
International Vaccine Codes

Vocabulary Governance & Distribution Challenges

International Vaccine Codes

Vaccine Code Set Considerations

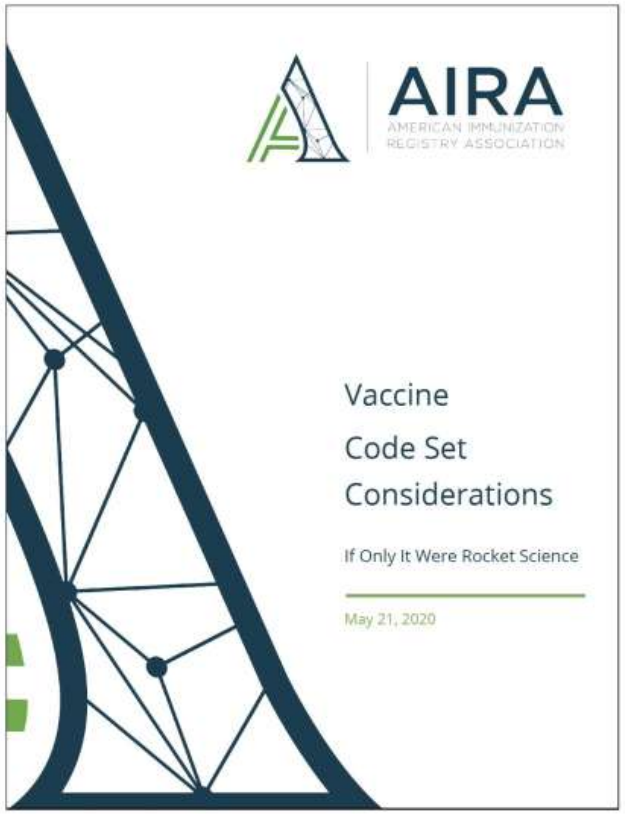




International Vaccine Codes

Code Set Management Challenges

1. Change Management
   - Maintaining awareness of code set changes as they are published and the process for implementing those changes
2. Synchronization
   - Keeping multiple systems and environments current with updates
3. Timeliness of Implementation
   - Identifying processes and expectations for timely code set updates across IIS and EHRs
4. The need for Supporting Data/Specifications
   - Identifying additional data points and interpretation needed to augment and more fully leverage vaccine code set date



International Vaccine Codes

Challenges

Change Management

Challenge: Staying current with code set changes (NDC, CVX, etc.)

Process Improvement Opportunities: Leverage code set web service, automate notifications, share with partners

Synchronization

Challenge: Ensuring synergy across multiple IIS environments

Process Improvement Opportunities: Automate updates to production, test, training, etc., create central reference tables

Timeliness

Challenge: Lack of clear expectations and process for updating new codes in a timely basis

Process Improvement Opportunities: Clarify roles (IIS vs. Vendor), reduce manual steps, explore collaborative IIS/EHR guidance

Need for Supporting Data

Challenge: Some code sets don't have all of the data elements necessary to managing the processing of code set changes

Process Improvement Opportunities: Build out full specifications to support automation of new codes

Updating Code Sets

- Why does it take time to update code sets in IIS and EHRs?

- While creating test cases for Measurement & Improvement we had an *aha moment!*

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Measurement & Improvement

- Creating test cases for changes from 03/18/2019 until 02/12/2020
  - Challenge: Translating human language into operational expectations
    - Most of the contextual information is expressed for a human to understand
    - Requires a vaccination expert to read, understand and implement
  - Highlighted 14 changes that needed further clarification
    - Generated 32 unique questions under these changes
    - A vaccination expert should be able to provide a workable answer to these questions
      - But these experts might not come to the same answer
  - Will show you two basic examples:
    - Two manufacturers merged
    - NDC's retired

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Example Change: NDC Retired

02/12/2020: NDC Codes Retired: The following NDC codes have been retired from the FDA files received.

...

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What does retired mean? How would this appear in operation?

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Example Change: NDC Retired

02/12/2020: NDC Codes Retired: The following NDC codes have been retired from the FDA files received.

…

What does retired mean? How would this appear in operation?

What should an IIS do when they receive "retired" codes:

- Should they be accepted and stored?
- Should they ignore them?
- Should they send back a warning or error?

When should this retirement take affect:

- As of the announcement date?
- As of the OuterEndDate/UseUnitEndDate?
- What if these dates are not specified?
- After these dates might the vaccine still be in circulation with these NDCs?

Can these codes still be used to report older data?
Can IIS continue to store older data with these codes?
Is it okay for IIS to report these older codes out for old data?

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What is Needed in the U.S.

- Code set project needs the same resources:
  - Need standard definitions and operations
  - Need additional supporting data
    - Need more start and end dates, and connect those to specific requirements
    - Need to code information from human language into a computable resource
  - Test cases that can be used to verify support for changes:
    - IIS HL7 test cases
    - EHR behavior test cases
- Keep up-to-date with every change to the code set

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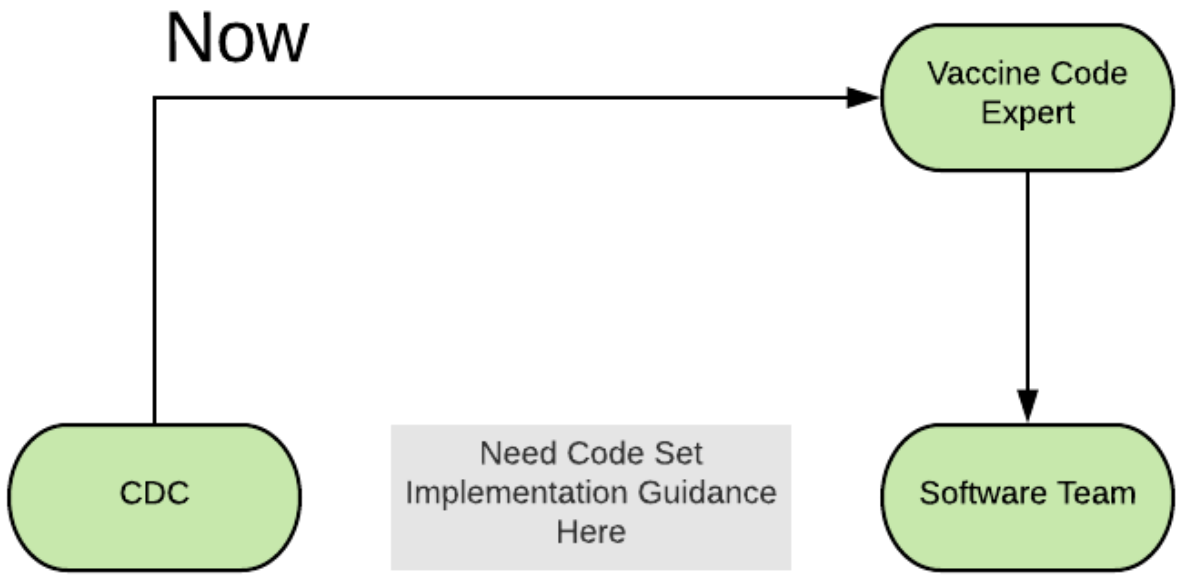
What is Needed in the U.S.

- Where are the roadblocks?
  - Downloading codes
    - Not too hard today
  - Implementation by expert
    - Experts are busy
    - Not all teams have them
- Need guidance that can bridge the gap



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How Could NUVA Help?

- Bridging Human Concepts and Machine Reasoning
  - Consolidates vaccine concepts across systems and countries
  - Provides a structured model using RDF (linked data)
  - Makes relationships computable with SPARQL
  - Enables precise mapping, discovery, and validation of vaccine data

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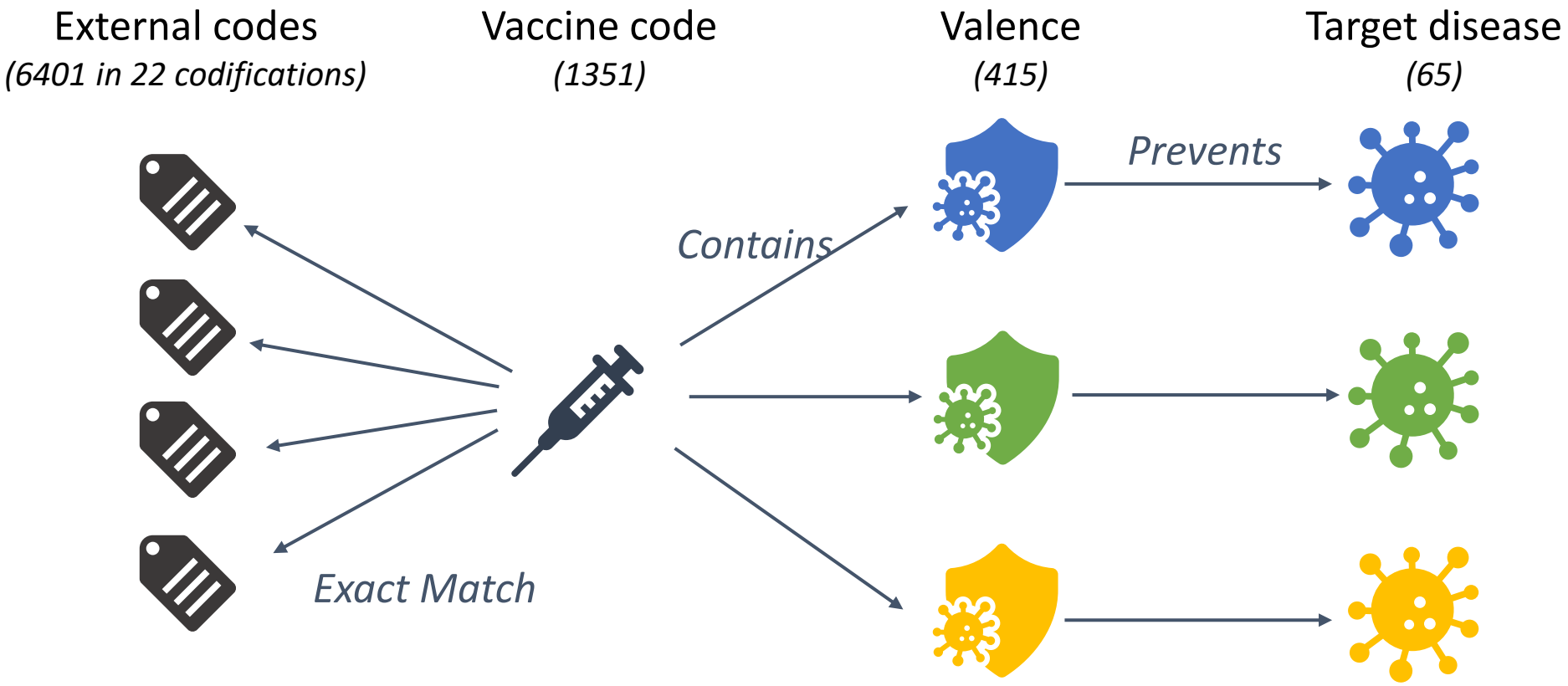
Practical use of the NUVA

TOOLS AND RESOURCES

NUVA data model



Counted on April 15th, 2025

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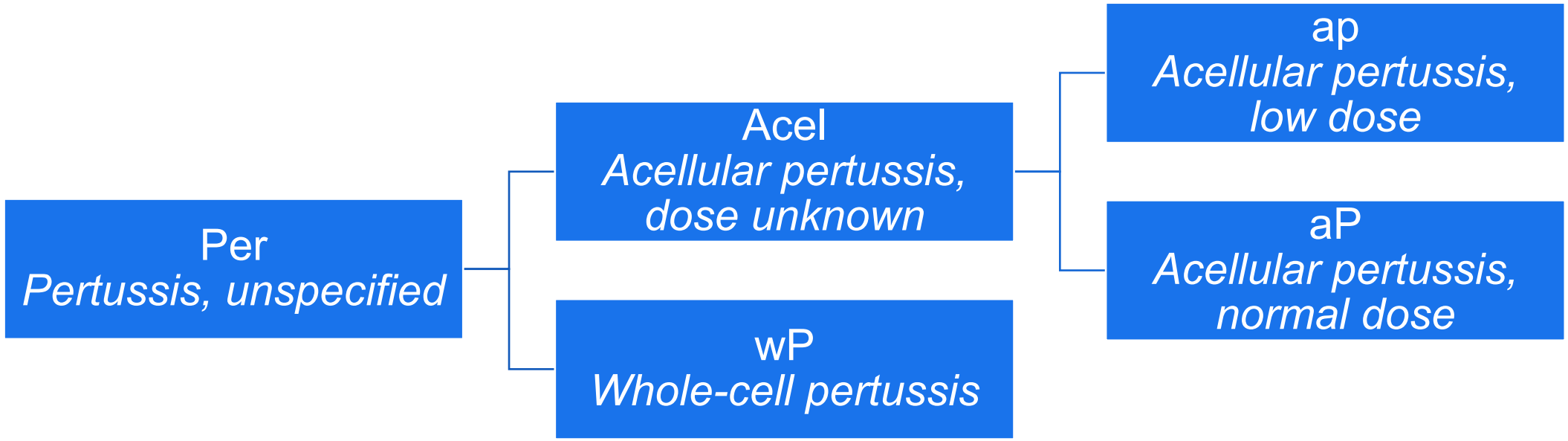
Hierarchical representation of valences

Allows to describe vaccines that are not fully identified.
Illustrated here with the case of pertussis valences



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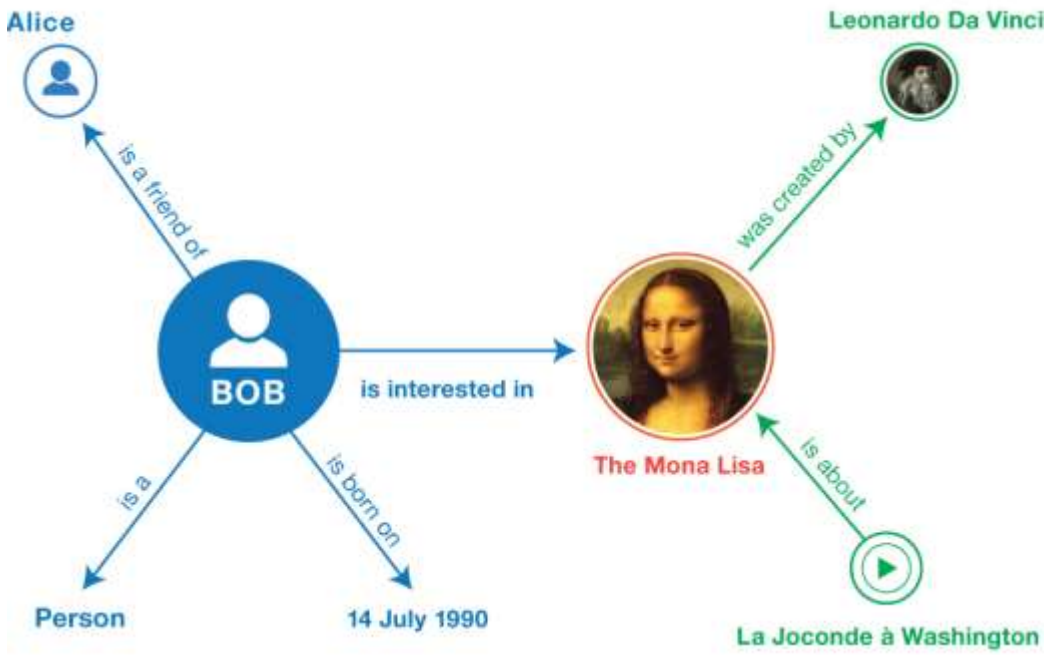
Resource Description Framework (RDF)

https://www.w3.org/TR/rdf11-primer/

- A standard model for representing information
- Not a messaging format like HL7 or FHIR
- Data model for describing relationships
- Uses triples
  - Subject – Predicate – Object
- Usually each is a URI (like a website address)
  - Everything is unambiguous and linkable across systems



EXAMPLE 1: Sample triples (informal)

```
<Bob> <is a> <person>.
<Bob> <is a friend of> <Alice>.
<Bob> <is born on> <the 4th of July 1990>.
<Bob> <is interested in> <the Mona Lisa>.
<the Mona Lisa> <was created by> <Leonardo da Vinci>.
<the video 'La Joconde à Washington'> <is about> <the Mona Lisa>
```

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Where You'll Encounter RDF

- NUVA
- SNOMED CT (internally modeled with RDF)
- LOINC (Regenstrief distributes an RDF version)
- Wikidata / WikipediaWHO vocabularies (emerging)
- FHIR supports RDF as one of its serialization formats

The RDF representation

- Used to represent knowledge as triples: Subject Predicate Object
- Subjects and Predicates are URLs, Objects can be URLs or Literal values.
- URLs can be shortened with prefixes.

The example below expresses that VAC1397 (subject) contains valence (predicate) VAL051 (object)

```
PREFIX nuva: http://ivci.org/NUVA/
PREFIX nuvs: http://ivci.org/NUVA/nuvs#

nuva:VAC1397   nuvs:containsValence:  nuva:VAL051
```

RDF triples can be represented with various formats: JSON, XML, Triples, Turtle, etc.

Turtle: A Friendly Way to Write RDF Triples

- TURTLE: Terse RDF Triple Language
- Preferred for readability

Subject	Predicate	Object (Value)
nuva:VAC1397	rdfs:label	"PANFLU"
nuva:VAC1397	nuvs:containsValence	nuva:VAL051
nuva:VAC1397	nuvs:isAbstract	false
nuva:VAC1397	dcterms:created	"2025-04-08"^^xsd:date
nuva:VAC1397	rdfs:comment	"Influenza A(H5N1) vaccine..."@en
nuva:VAC1397	rdfs:subClassOf	nuva:Vaccine
nuva:VAC1397	skos:notation	"VAC1397"

```
nuva:VAC1397:
        rdfs:label "PANFLU" ;
        nuvs:containsValence nuva:VAL051 ;
        nuvs:isAbstract false ;
        dcterms:created "2025-04-08"^^xsd:date ;
        dcterms:modified "2025-04-08"^^xsd:date ;
        rdfs:comment "Influenza A(H5N1) vaccine
        rdfs:subClassOf nuva:Vaccine ;
        skos:notation "VAC1397"
```

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The RDF vocabularies

Some sets of terms, identified with a given URL/prefix, have a commonly accepted meaning.
We use:

- rdfs, that allows to characterize the subject as a class with attributes (a label, parents)
- skos, that defines terms regarding terminologies and ontologies
- dcterms, that defines terms regarding publications and releases

Complemented with a set of our own, nuvs, for NUVA specific relationships.

```
nuva:VAC1397:
        rdfs:label "PANFLU" ;
        nuvs:containsValence nuva:VAL051 ;
        nuvs:isAbstract false ;
        dcterms:created "2025-04-08"^^xsd:date ;
        dcterms:modified "2025-04-08"^^xsd:date ;
        rdfs:comment "Influenza A(H5N1) vaccine (fragmented virion, inactivated, adjuvanted)"@en ;
        rdfs:subClassOf nuva:Vaccine ;
        skos:notation "VAC1397"
```

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What is SPARQL?

- Query language for RDF
  - Just like SQL is a query language for relational databases
  - But instead of tables with rows and columns, queries a graph of triples (subject-predicate-object)

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Examples

📜 SQL (Structured Query Language)

> "Give me all patients whose vaccine is 'Polio'."

```sql
SELECT patient_id
FROM vaccinations
WHERE vaccine_name = 'Polio';
```

You need to know:

- The table name (`vaccinations`)
- The column name (`vaccine_name`)

🌐 SPARQL (SPARQL Protocol and RDF Query Language)

> "Find all vaccines that prevent smallpox."

```sparql
SELECT ?vac ?vl WHERE {
  ?dis rdfs:label "Smallpox"@en .
  ?val nuvs:prevents ?dis .
  ?vac nuvs:containsValence ?val .
  ?vac rdfs:label ?vl .
}
```

You're querying a **web of facts** like:

- Vaccine A contains valence B
- Valence B prevents disease C
- Vaccine A has a label

You don't need to know a "table" — you just follow the **relationships** in the RDF graph.

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The SPARQL query language

Allow to query from an RDF graph (set of triples) by expressing constraints on variables, with various constructs to filter further, aggregate results.

A SPARQL engine preloaded with NUVA is available at https://graph.ivci.org/sparql, with a set of example queries.

```
# Retrieve all vaccines having a valence against smallpox

SELECT ?vac ?vl WHERE {
 ?dis rdfs:subClassOf nuva:Disease .
 ?dis rdfs:label "Smallpox-Monkeypox"@en .
 ?vac rdfs:subClassOf nuva:Vaccine .
 ?vac rdfs:label ?vl FILTER(lang(?vl)='en'||lang(?vl)='').
 ?vac nuvs:containsValence ?val .
 ?val nuvs:prevents ?dis
 }
```

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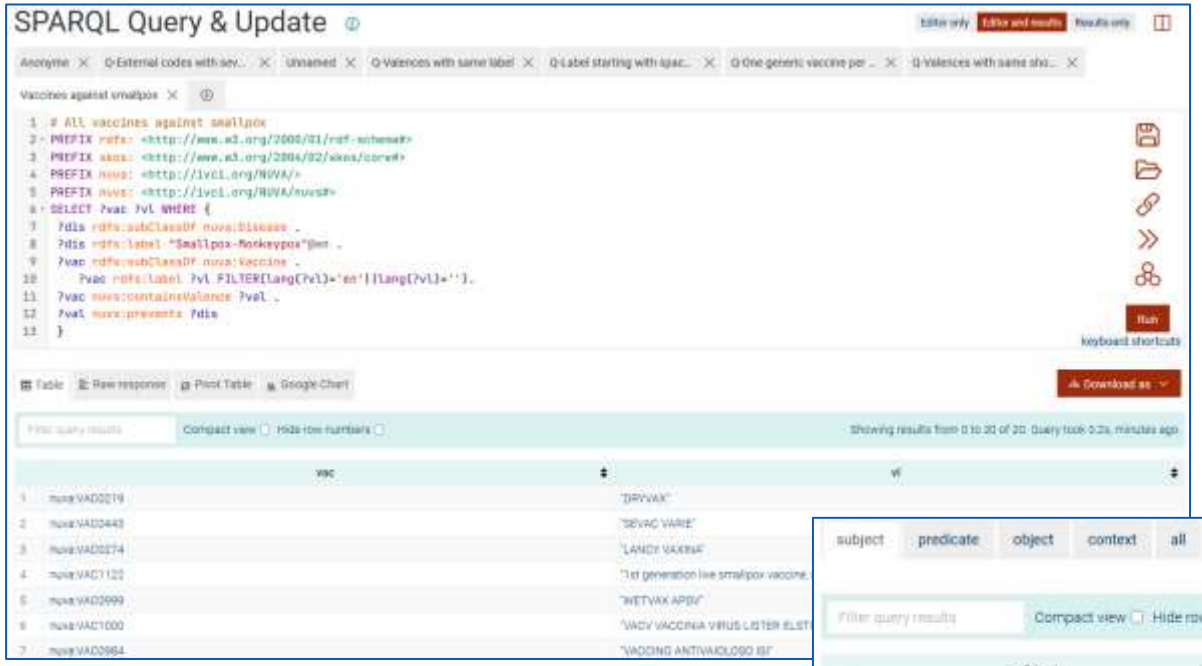
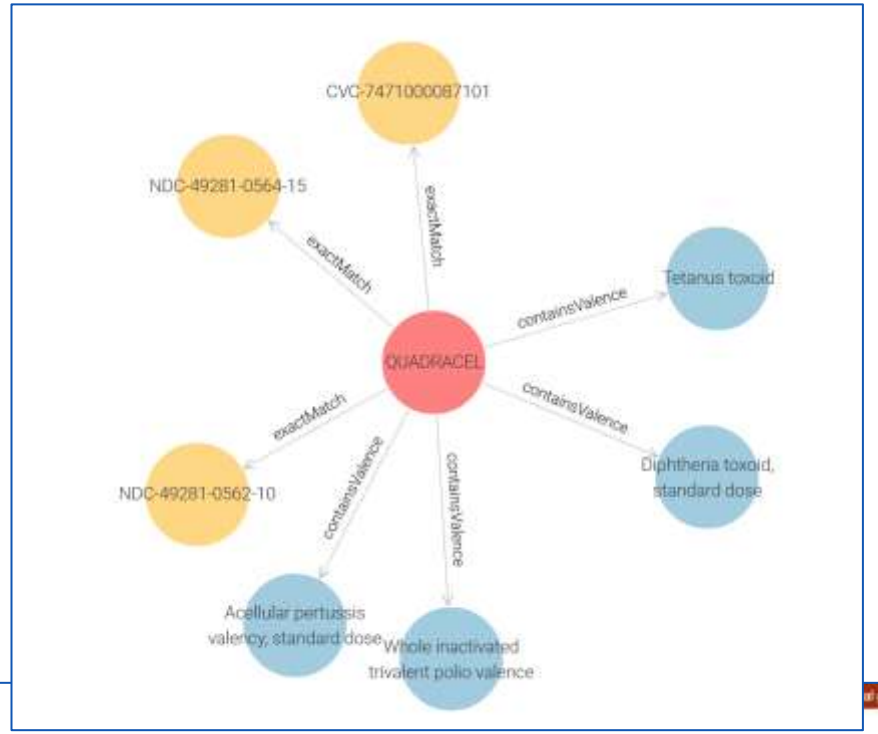
Using graph.ivci.org

SPARQL queries



Visual graph



Browsing

subject | predicate | object | context | all

Filter query results | Compact view | Hide row numbers

	subject	predicate	object	context
1	http://ivci.org/NUVA/VAC1397	nuvs:containsValence	http://ivci.org/NUVA/VAL051	http://www.ontotext.com/explicit
2	http://ivci.org/NUVA/VAC1397	nuvs:isAbstract	"false"	http://www.ontotext.com/explicit
3	http://ivci.org/NUVA/VAC1397	dct:created	"2025-04-08"	http://www.ontotext.com/explicit
4	http://ivci.org/NUVA/VAC1397	dct:modified	"2025-04-08"	http://www.ontotext.com/explicit
5	http://ivci.org/NUVA/VAC1397	rdf:type	owl:Class	http://www.ontotext.com/explicit
6	http://ivci.org/NUVA/VAC1397	rdfs:comment	"Influenza A(H5N1) vaccine (fragmented virion, inactivated, adjuvanted)"	http://www.ontotext.com/explicit
7	http://ivci.org/NUVA/VAC1397	rdfs:comment	"Vaccin contre la grippe A(H5N1) (virion fragmenté, inactivé, avec adjuvant)"	http://www.ontotext.com/explicit
8	http://ivci.org/NUVA/VAC1397	rdfs:label	"PANFLU"	http://www.ontotext.com/explicit
9	http://ivci.org/NUVA/VAC1397	rdfs:subClassOf	http://ivci.org/NUVA/Vaccine	http://www.ontotext.com/explicit
10	http://ivci.org/NUVA/VAC1397	skos:notation	"VAC1397"	http://www.ontotext.com/explicit

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Online NUVA contents: ivci.org/nuva

- nuva_ivci.rdf: full NUVA graph, RDF format
- nuva_core.ttl: minimal graph with Vaccines, Valences and Diseases, in English only, Turtle format
- nuva_core.csv: only the list of vaccines, with label and comment in English, CSV format

- nuva_lang_xxx.ttl! Additional triples to add language xxx, Turtle format

- nuva_refcode_xxx.ttl: Additional triples to add external code xxx, Turtle format
- nuva_refcode_xxx.csv: Tabular mapping of external code xxx with NUVA, CSV format

- history.html, history.json: History of NUVA releases
- version; currently exposed version of NUVA

Using NUVA in Python

A package nuva-util can be installed with command : pip install nuva-utils

It exposes functions to:

- Get the current version
- Download the core graph from https://ivci.org/nuva
- Add external codes or languages to a graph
- Obtain the list of vaccines and their attributes
- Obtain a translation table from a language to another
- Determine the optimal mappings between an external code system and NUVA

See https://ivci.org/doku/doku.php?id=ivci:nuva-utils for details and an example.

Demonstration of a Python utility to compute metrics on a code system

Resources for developers

Wrappers are available for 6 programming languages:

- Ruby
- TypeScript/JavaScript
- Java
- C#
- Python
- PHP

They:

- Are available from common package managers (NPM, Ruby Gems, PyPI, Maven, NuGet, Composer)
- Expose the NUVA concepts as language specific constructs
- Simplify the use of data, fetching it from a public CDN
- Offer a consistent API across all languages

Their documentation is available at https://docs.nuva.mesvaccins.net/