Provision of Options
and Recommendations for an EU Citizens'
Vaccination Card

Excerpt from

Final report
Data collection and mapping for an EU citizens' vaccination card

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1. Digital vaccination cards: interoperability considerations

Summary

To develop a EVC that is portable and inclusive of all countries, we considered the interoperability of Immunisation Information Systems (IIS) and The Patient Summary that is currently designed in the eHealth Digital Service Infrastructure (eHDSI) for cross-border cooperation.

dVCs need to be 'portable' and in the custody of the citizen to enable cross-border use. 'Portability' of dVC relates to sharing of vaccination data (e.g., into local or remote, public, or private repositories) at the initiative, and under the control of, the citizen. 'Global availability' of vaccine data relates to the real-time fetching of foreign data by the health professional (the aim of the eHDSI Patient Summary). Both require some level of interoperability, but not with the same constraints. eHDSI was designed to enable health professionals to retrieve information about patients in other countries and was not designed to involve nor empower the citizen, as is expected from the dVC. While vaccination is recorded in eHDSI, it is not a major consideration – the eHDSI patient summary places it focus on other areas. eHDSI is particularly strong for emergency care for example. While there are many differences in purpose, there are many technical similarities in execution. The two initiatives each bring value and should coexist, sharing technical building blocks so that the dVC and eHDSI systems are developed and strengthened without duplication of effort.

IIS in different European countries are not interoperable as they have evolved separately to support the provision of vaccinations in different epidemiological contexts, health systems, and languages. As they were developed individually at the Member State level as opposed to through a pan-European effort, they are not aligned at either the semantic or structural levels and therefore cannot exchange information. While no country is mandated to do so, interoperability would bring value at both the national and European levels and could be supported by developing and then adopting commonly agreed standards that align IIS, enabling them to exchange information. Structural interoperability could be supported by consistent use of HL7 CDA and HL7 FHIR standards. We found that HL7 CDA and HL7 FHIR standards emerged as the common ground between different systems. Semantic interoperability could be improved by developing vaccination codes that use both a local, context dependent descriptor (e.g., pharmaceutical code) in addition to a range of descriptors that are characteristic both across borders and over time. We found that most IIS coded vaccines using national pharmaceutical codes. While this coding works at the national level it does not work across borders which presents a challenge to both the portability and global availability of vaccine data. **To be inclusive of the continually evolving range of vaccination descriptors, dVCs will need to handle both historical and/or 'foreign' data.**

A dVC and pVC will need to coexist to ensure any VC is inclusive of all citizens. The dVC needs to be presented to citizens using a 'rendering system' that tailors the information displayed to purpose, audience, and in-line with local immunisation policy. Some existing Immunisation Information Systems (IIS) present a citizen portal that may be considered as an approximation of the rendering for the dVC. Yet, they do not propose any kind of portability.

1.1. Definitions and issues

1.1.1. Definition of the dVC

dVC need to be 'portable' and in the custody of the citizen to enable cross-border use. 'Portability' of dVC relates to sharing of vaccination data (e.g., into local or remote, public, or private repositories) at the initiative, and under the control of, the citizen. To exercise the right to portability as is stated in Article 20 of the GDPR, the citizen must have the control of the access to their own data.

Here we view the dVC as a pivoting platform that takes information from data repositories (such as IIS) and renders it to citizens. We did not find any examples of dVC that enabled citizens to take ownership of the data by granting permission to health professionals to access and edit their vaccination information (our vision) but we did identify several features of IIS systems that rendered information to citizens in a way that could provide inspiration for the design of a citizen-focused dVC. Here, in order to gain insights for VC development, we therefore include any system where digitalised vaccination history was made available to the citizen through access either on mobile or computer, including printouts from Electronic Health Records (EHR) or Immunisation Information Systems (IIS). IIS that did not enable access by citizens were not included.

Our vision of the dVC concept is illustrated in Figure 1: Citizens can store their own vaccine data 'at home' in a 'passive repository' – a storage system which would enable viewing but not editing of the vaccine information. This could be a device (e.g., smart-card, computer, or smartphone) or simply a paper card. This data would also be stored in one or several 'active repositories' – data system(s) within which content can be modified. This repository could be a public system (e.g., a national IIS) or a private initiative, and the citizen would be able to decide how the information could be shared. They would for example have the authority to grant access to the data to health professionals who could choose to upload a CDA file from the national IIS of their origin country, and transfer it to the software of their General Practitioner, enabling them to view the information, store it on their system (e.g., an EHR), and edit it (e.g., add a new vaccine administered to the record).

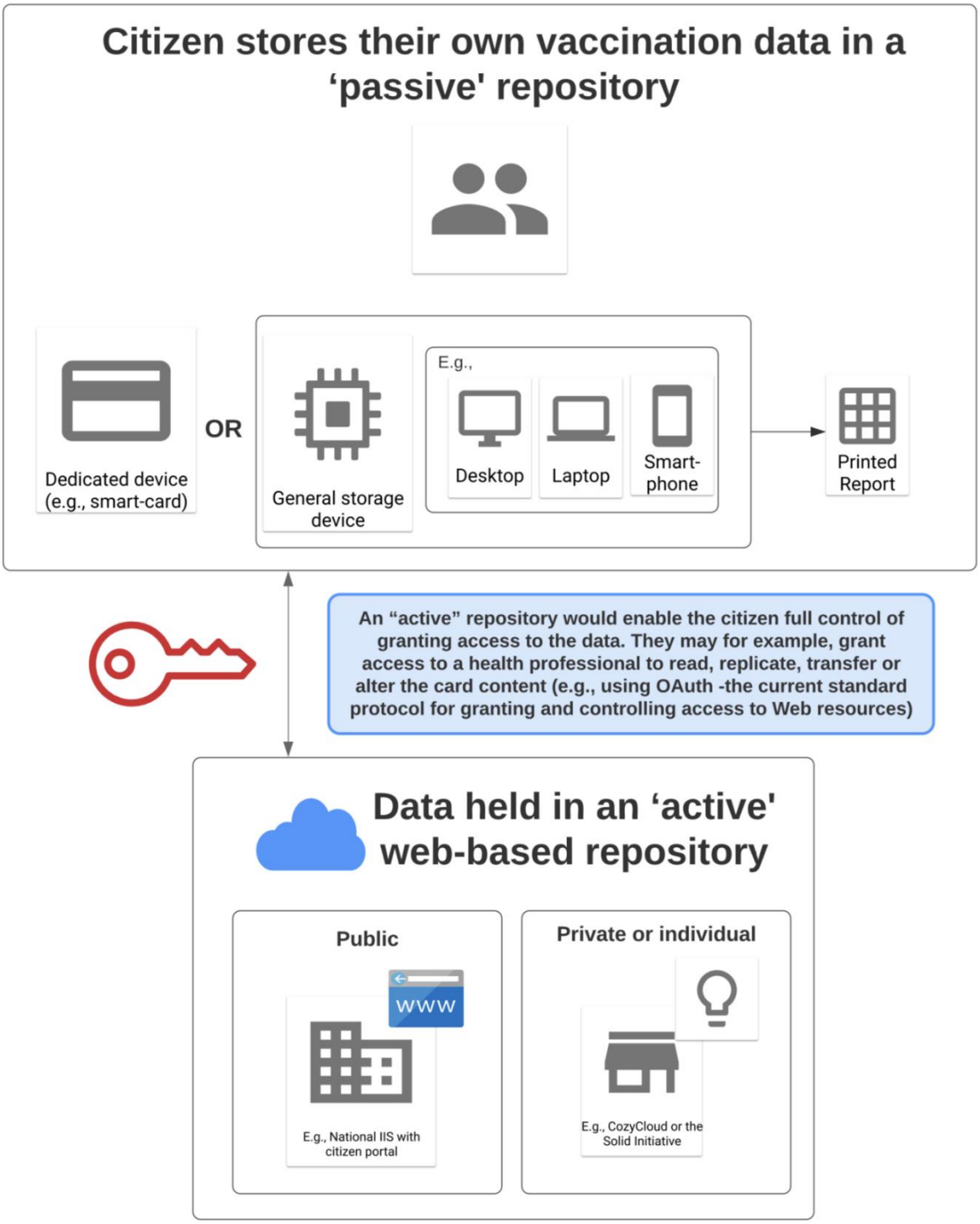


Figure 1. The dVC concept

More information about the examples CozyCloud and the Solid Initiative can be found on their websites (16) (17).

1.1.2. Rendering of the dVC

In essence, when we refer to the dVC, we are referring to a technical exchange format, or a 'pivot' format, between a variety of information systems. This can be considered in terms of the following elements:

- "dVC document" - a portable format that enables the vaccine information to be carried by the citizen.
- "dVC protocols" which define the interactions between different systems.
- "dVC infrastructure" which includes:
  - "Repositories" in which data is stored
  - "Rendering servers" that provide a human readable representation of a dVC. These can be developed to allow different user functions to be built in to meet different needs in different contexts, i.e., they can be 'contextualised'.

A number of functions can be built into a renderer. For example, in most contexts the provision of immunisation history, information on vaccination, and vaccination reminders would be useful functions for a citizen. The functions built into rendering servers need to be in line with the needs in a specific context, for example with the rules defined by the local National Immunisation Technical Advisory Group (NITAG). While the NITAG would encode the rendering system with the rules, at the other side the information would be rendered to the citizen that was tailored to their specific needs. To ensure tailoring to the needs of a particular citizen, they would be asked to provide some information (e.g., profile data) to the server. The interface, or 'rendering' piece of the dVC would then aim to deliver the information to the citizen in a user friendly and inclusive way that aimed to ensure equitable access : While a digital card would have many benefits over a physical card in terms of tailoring information to diverse audiences (as is discussed in previous sections), having a pVC for access would also be necessary to ensure access for all. This physical card would be provided by a rendering or contextualisation server (e.g., the IIS of their place of residence) and could for example be printed locally or sent through the mail from a trusted authority. Citizens would hold this card and would then be able to use it to grant access to officials (e.g., health professionals or public health authorities) in other administrative areas (e.g., different countries) when their vaccinated record was needed. Health professionals would then be able to use the data via their local EHR system or an IIS (Figure 2).
A system rendered in this way should lead to citizen empowerment. By having access to their personal vaccination information and guidance on local vaccination policy (e.g., scheduling) citizens would likely be more informed and enabled to play a more active role in managing their vaccinations. By managing the sharing of their personal data, citizens will also feel more in control which may help to ameliorate some of the concerns expressed by those opposed to vaccination.

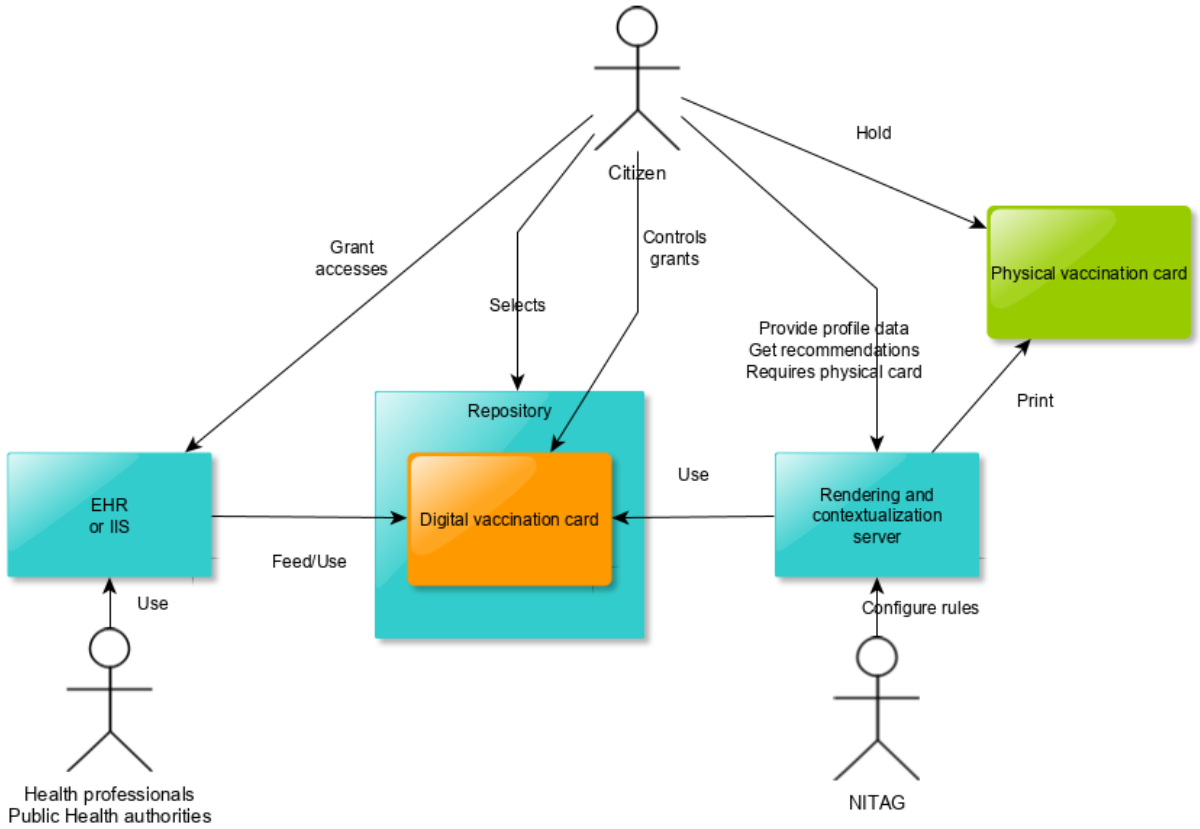


Figure 2. Interaction between EHR, active repository, and contextualization server

1.1.2.1. Semantic interoperability

In this section we discuss semantic interoperability in relation to any kind of pre-existing vaccination records, either within a physical vaccination card (pVC), an Immunisation Information System (IIS) or a general-purpose Electronic Health Record (EHR).
The pVC handles only a subset of the data elements held in an IIS. This is both because of the different origins and purposes of pVCs and IIS, in addition due to feasibility considerations: space on a pVC is limited and it is not possible to continually change data elements as it necessitates the development of a new card version. pVC hold information on the vaccine recipient, in addition to vaccination events:

- *Vaccine recipient related data (name, age, gender, etc.)*: An identity check should take place when the dVC holder provides the card in-person. Traditionally, these types of identity checks are based on name, surname, birthplace, and birthdate. This basic information should therefore be incorporated into physical cards, while more detailed information will be held on the IIS.
- *Vaccination event related data***:** The date of administration and the name of the vaccine administered are essential, as is information about the vaccine provider for vaccination records that are used as 'proof' of vaccination (e.g., for travel). Other information such as batch number and expiry date, route and site of vaccine administration may also be collected. Existing designations used to code the vaccine administered are diverse, and particularly variable across different languages and countries (see Box 6). Labels and descriptive terminology need to facilitate accurate vaccine identification by both healthcare professionals and citizens. This includes alternative or related vaccine names and dates of availability of the product (e.g., from a string of characters or a batch number, presentation of vaccines marketed on a given date).

Some semantic interoperability challenges have already been addressed (e.g., alternative calendars) by all administrative information systems, but many remain. The most critical challenge in terms of a dVC is that existing international standards for vaccine coding are insufficient. Although they are insufficient, they are not redundant however, and we recommend basing any new dVC system as much as possible on standards that are already commonly used. This will enable past efforts to be capitalized upon, for example, the eHDSI plans to rely on a combination of SNOMED-CT and ATC as its Master Value Set for vaccines (for more information on SNOMED-CT and ATC see Box 6). We suggest that the eHDSI relies upon a more global, vaccine dedicated code system. Our vision is that both eHDSI and dVC document producers use the same dictionaries to transcribe from the locally used code systems to this global reference.

1.1.2.2. Structural interoperability

For different IIS and EHR to read, update or create a dVC, systems need to be structurally interoperable. Two kind of exchange formats exist:

1. **Transaction oriented exchange** (for interactions between the IIS and third parties). This category is quite diverse and lays upon the pre-existing infrastructures for exchanging medical information: KMEHR (Belgium), FMK (Denmark), ebXML (Norway) HL7v2 (US), etc. More recent systems, e.g., the Lithuanian ESPBI or Portuguese eBoletim de Vacinas, use HL7 FHIR resources and interactions.
2. **Document oriented exchange**, where the underlying transaction is a content neutral exchange protocol. HL7 CDA profiles are used except for the FHIR based systems that use FHIR bundles.

Box 6. Variation in coding for vaccines in paper and digital systems

We observe variations by:

- *Brand name* e.g., the same quadrivalent vaccine manufactured at a single production site by the same manufacturer (GSK) in Europe is BoostrixTetra in France, Polioboostrix in Italy and Boostrixpolio in Belgium.
- *Antigen designation* e.g., "DT-IPV" (Diphtheria-Tetanus-Poliomyelitis) or DTaP (Diphtheria-Tetanus-Acellular pertussis)
- *Vaccine preventable disease designations*, such as "Pertussis" or "Hepatitis B".
- *Abbreviations for monovalent or combined vaccines*
- *Conjugation protein for vaccines against encapsulated bacteria*

In digital systems, codes are defined within each country and to our knowledge, there is no international terminology capable of coding both brand names of active and inactive vaccines as well as generic names of antigens or vaccine preventable diseases in most languages and countries in all EU Member States and EEA countries, plus other countries identified to be of particular interest by vaccine experts. Examples of mechanisms used include:

- *Drug delivery encoding scheme used by the health insurance system* (e.g., CIS in France, CNK in Belgium, PZN in Austria, NPAKID in Lithuania, etc.).
- *International codes* (e.g., ATC, SNOMED-CT, CVX). ATC only addresses target diseases or antigens, with a rather imprecise information (e.g. J07BD01 encodes "measles, live attenuated"). SNOMED-CT provides a short description in a limited number of languages. This description lacks granularity and precision, so this terminology does not allow for a proper assessment of the vaccine protection of individuals, mixes up valences and dose ranks, and in its native form does not handle brands, which are often reported on paper records.
- *Local extensions of international codes* (e.g., SNOMED-CT variants). UK and Canada have implemented local extensions to make SNOMED CT more specific, but these extensions are only in English (UK) or English and French (Canada) and include only active vaccines branded in the country
- *Totally specific coding systems*. CVX (USA) is available only in English. This vaccine code set combines antigen and manufacturer information (through an additional MVX code), which requires specific encoding tweaks when product portfolios are acquired, and it is limited to vaccines commercialized in the US.

Special focus point on vaccine designations

BoostrixTetra vaccine includes four antigens: diphtheria toxoid "d" (the lowercase letter "d" indicates a reduced antigen content, the uppercase letter "D" indicates a normal antigen content), the tetanus toxoid "T", the pertussis antigens "ap" (for acellular pertussis, reduced antigen content; there is also an antigen called "aP" that indicates a normal antigen content). A vaccine with reduced content ("d" and/or "ca") is used in adults, adolescents or older children properly primed with "D" or "Ca". The ATC code of Boostrixtetra is "J07CA02", which is a "diphtheria-pertussis-poliomyelitis-tetanus vaccine": this code does not differentiate between pediatric and adult antigens ("d" and "D"; "ca" and "D"). Without this information, in many situations it will not be possible to assess the level of protection of a person who has received this vaccine; it will also be difficult to predict the type of vaccine to be used for the next dose (and its date of administration).
Shingles vaccine is SCTID 722215002 "Administration of herpes zoster vaccine" in SNOMED CT coding. This description does not inform the user of the difference between the live vaccine from MSD and the inactivated vaccine from GSK, while this knowledge is crucial both to assess the putative efficacy of the vaccine and its contraindications.

1.2. dVC and the patient summary of eHDSI

The eHDSI is a network of national contact points in eHealth (NCPeH) that can transfer information between one another at the national system level, and convert data from the national level so that it can be used at the local level (e.g., an EHR). Rather than creating a separate system and duplicating efforts, we propose that any dVC utilises the same machinery for conversion as eHDSI in order to leverage and strengthen existing efforts. Some considerations are listed below:

- **The dVC and eHDSI both propose 'pivot' formats that can be produced or consumed by any IIS**. The eHDSI patient summary format includes a Vaccination section within the History of past illness section in its extended (optional) data set. Here, vaccination events are recorded with their date, brand name, vaccine code (SNOMED-CT or ATC) and target disease.
- **The patient summary is a transient format that flows in real-time between National Contact Points for eHealth, while the dVC is a persistent format stored and exchanged under the control of its owner – the citizen.** This difference in use necessitates differences in format. The dVC is a living document that evolves with its owner during his whole lifetime. It will need to include vaccination records from many sources (including information systems that do not exist yet) and be tamper proof to prevent fraud.
- **Digital signatures are needed** for the integrity of each individual record and of the assembly. Such a feature does not exist in the interoperability standards that are defined for the instantaneous transmission between two trusted systems, so some adaptation will be required.
- **eHDSI does not use or produce dVCs** but to it makes sense to align the systems and not duplicate efforts using the same conversion elements, such as vaccine designation terminology. By adopting the same terminology, the interoperability of information systems through eHDSI will determine their ability to generate dVCs (Figure 3).

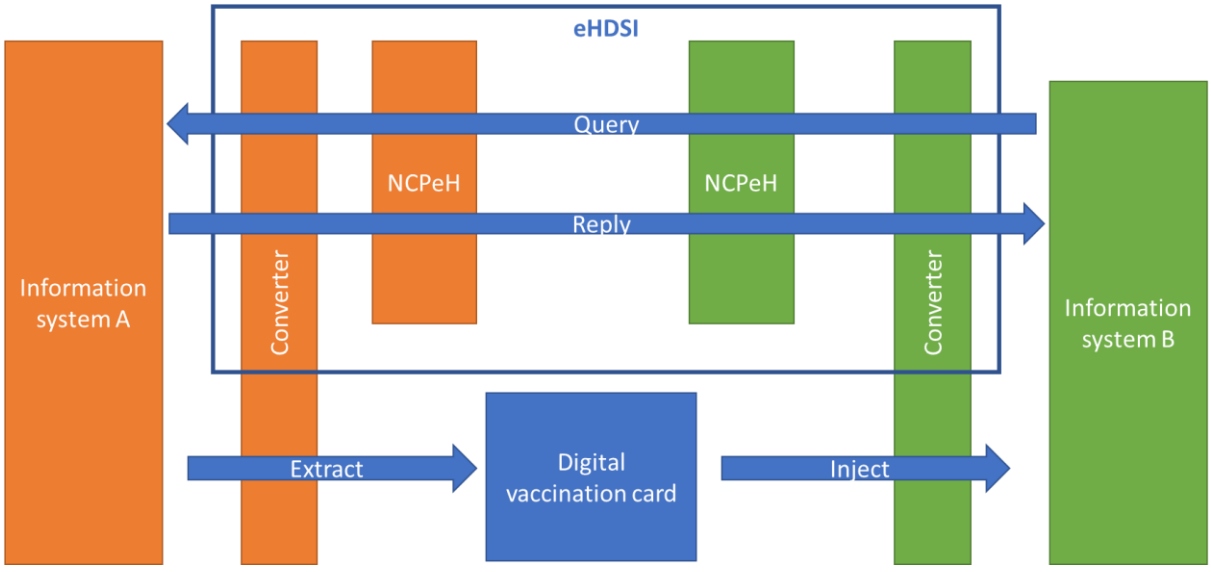


Figure 3. dVC and eHDSI

In current eHDSI specifications (value set eHDSIVaccine dated of June 17th,2020), the representation of vaccines is a value set gathering codes from the SNOMED International version and from the WHO ATC classification. The ATC codes have been added only since April 22nd, 2020. A structured ontology like the ones implemented in the Danish IIS Det Danske Vaccinationsregister (DDV) or the French IIS MesVaccins would be more relevant, either as a standalone European initiative or a SNOMED-CT extension (provided that the SNOMED-CT licensing issues have been solved).

1.3. dVC and IIS

As no portable dVC currently exists, IIS with citizen portals constitute the best existing approximation we have of a dVC.
Health information systems, including IIS, may play either the role of the producer or the consumer in relation to the dVCs. For example, they may:

- Produce dVCs based upon its own records
- Receive dVCs from people entering a national health system
- Perform reconciliation of divergent versions of a dVC
- Act as an active repository for dVCs deposited by citizens
- Act as a renderer for dVCs
- Act as a contextualization system to provide personalized recommendations based upon the NITAG rules.

These interactions will be described, and possible technical protocols will be proposed in D9.3.

It is likely that in time, IIS will emerge to be a producer of pVC as opposed to a consumer. This can already be seen in countries where the IIS has reached a sufficient level of maturity (e.g., Norway), where the independent pVC has disappeared due to its lack of utility. In these settings if there is a specific need for a physical record (e.g., administrative proof of vaccination or travel abroad), health facilities may deliver stamped printouts of the IIS contents upon request.
The two aspects of the IIS that we have observed from existing systems to be the most relevant when it comes to the handling of VCs, are the encoding of vaccines and the technical format they already use when communicating with other information systems.

Table 37 summarizes the findings on the different IIS. More detailed information collected for each country is presented in Section 7.4.

		Exchange format	Vaccine product encodings				
	System		PharmaCode	ATC	SNOMED-CT	CVX/MVX	Custom
AT	ELGA	CDA	PZN	X			
BE	Vaccinnet	KMEHR	CNK	X			X
HR	CEZIH		JLL				
CZ	ZOPIK						
DK	DDV	FMK		X			X
EE	DIGILUGU	CDA		X			X
FI	RokotusRekisteri	JSON	NAN	X			X
FR	DMP	CDA	CIS	X			
FR	MesVaccins	FHIR					NUVA
EL	AIFY						
HU	EESZT						
IT	ANV	XML	AIC				X
LT	ESPBI	FHIR	NPAKID				
MT	MyHealth	CDA		X			
NL	Praeventis						
PT	E-Boletim de Vacunas	FHIR	X		International		
RO	RENV						X
SI	eRCO		CBZ		International		
ES(AN)	Diraya						X
SE	NVR		NPL-ID				
UK	eRedBook				Extension		
US	MIROW guides	HL7v2	NDC			X	
CAN	CANImmunize				Extension		CVC
AU	AIR		AMT				X
IS	Heilsuvera			X			
NO	SYSVAK	ebXML		X			X
CH	MesVaccins	CDA		X			X

Table 37. Exchange formats and vaccine product encodings for different systems

1.4. Country-level information

This section summarizes the information collected from February 2020 until May 2020 among 35 countries (all EU Member States and EEA countries, plus other countries identified to be of particular interest by vaccine experts).
The collection process was hindered by the unavailability of public health authorities during the first COVID-19 peak. Most of the information was found online, although a few elements were provided from an unpublished survey driven by the EU Joint Action on Vaccination (EU-JAV).
As a result, for 9 countries, no evidence of an existing IIS could be found at that time: Bulgaria, Cyprus, Germany, Ireland, Latvia, Luxembourg, Poland, Slovakia, and Lichtenstein. Some of these 9 countries have initiated the implementation of an IIS since May 2020, with the primary objective of tracking COVID-19 vaccination, and with a secondary benefit of improving the monitoring of other vaccine preventable diseases. These solutions did not deviate from the standards already implemented in some other countries.
The 26 countries analyzed provide a clear view of the diversity of, and commonalities between existing solutions. The precision and completeness of the data collection was sufficient to allow for the identification of best practices. These will be discussed further in D9.3.

1.4.1. Austria

Summary	ELGA (elektronische Gesundheisakte) is a general EHR system accessible both to professionals and citizens. It is still under deployment. Within ELGA a pilot project for the dVC (e_Impfass) has been initiated in June 2018.
Syntax	The data exchange format is CDA profile Immunization Content. Two formats have been standardized: one for the full vaccination status of an individual, and one for documenting a change in the vaccination status.
Citizen identity	Citizens connect using a citizen e-card delivered by their health insurance or a companion smartphone application. A new version of e-id card will be deployed in 2020. The CDA record contains a set of identity trails, including the Social Security Number and a specific identifier for health named bPk-GH.
Vaccine designation	Vaccines are described with their name, PZN code, lot number, serial number, manufacturer, ATC code, components, and dose. The value set for vaccines can be found at https://termpub.gesundheit.gv.at/TermBrowser/gui/main/main.zul, under category elmpf-Impfstoffe_VS. Codes are OIDs under root 1.2.40.0.34.4.16.1, corresponding to HL7 Austria. The vaccine identifier is the pharmaceutical code PZN. The target diseases are also documented with SNOMED-CT codes (Figure 4).
Other terminologies used	SNOMED CT: identification of document and event type, of target disease, of antibodies, of past illnesses. LOINC: identification of sections in CDA document ATC: Vaccine antigens
Additional information	-
Rendering for citizens	No view was found, the access for citizens is not opened yet. This is planned and will constitute an additional example of a dVC.
Sources	General presentation of ELGA: http://www.elga.gv.at/en/about-elga/ dVC in ELGA: https://www.elga.gv.at/e-impfpass/e-impfpass/ Technical documentation of dVC: https://wiki.hl7.at/index.php?title=ILF:E-Impfpass Citizen portal: https://www.gesundheit.gv.at/ Citizen card: https://www.buergerkarte.at/faq-karte.html

Table 38. Austria

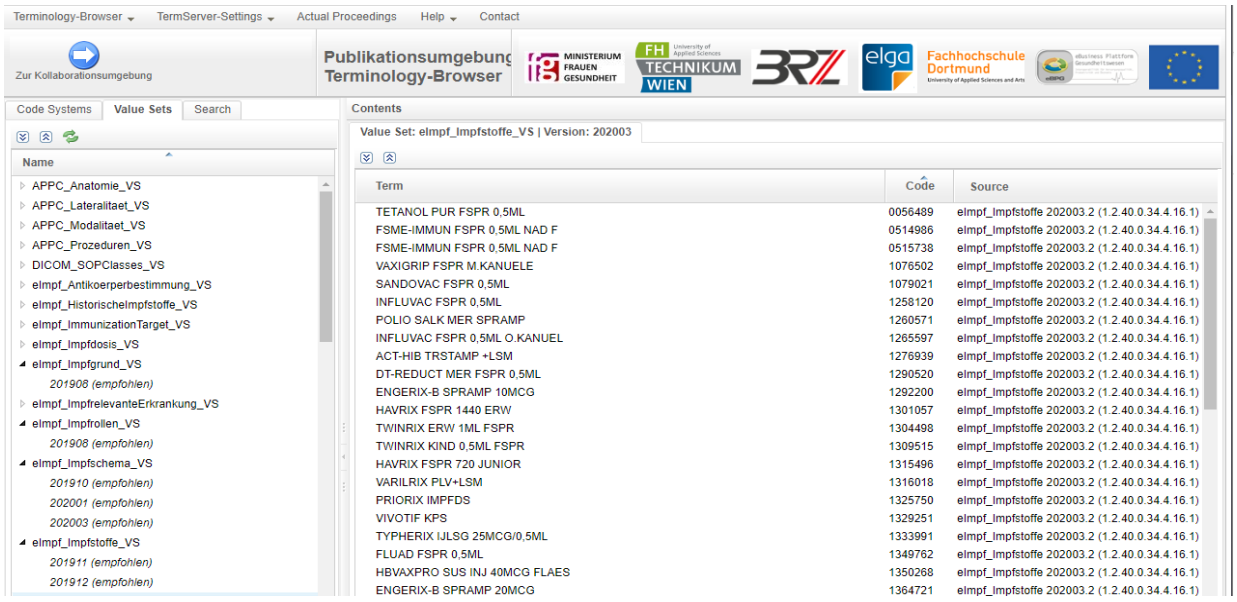


Figure 4. Vaccine designation, Austria

1.4.2. Belgium

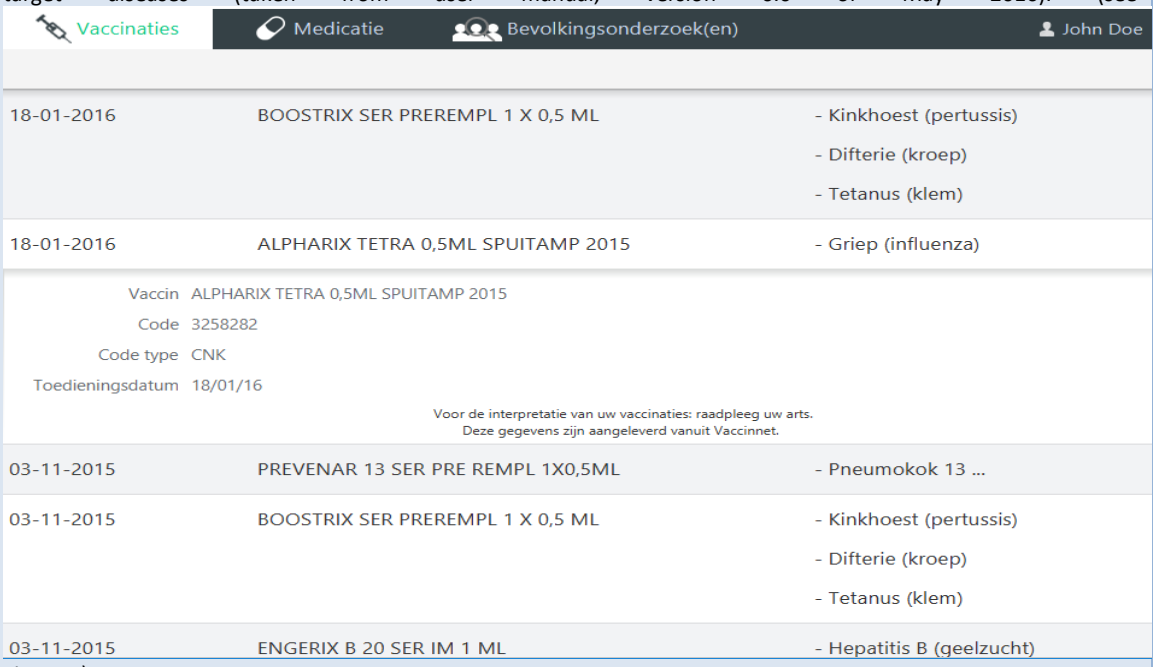
Summary	Two subnational IIS exist in Belgium: Vaccinnet for Flanders, E-Vax for Wallonia and Brussels. Vaccinnet is a mature solution, while e-Vax is said to have been derived from Vaccinnet in 2016, with the primary purpose to order vaccines. The documentation found regards Vaccinnet. Citizens have access to their records through the My Health Viewer application, that relies itself upon an API presented by the Vitalink system to query Vaccinnet (read-only access).
Syntax	The transfer format is XML, accessed through REST services under a message syntax named KMEHR (Kind Messages for E-Health Records), promoted by the Smals association.
Citizen identity	The citizen is identified by its family name, first name, social security identity number (INSZ), and optionally an additional insurance identifier (RIZIV number). It accesses the My Health Viewer portal with his e-ID card.
Vaccine designation	Three codes can be used to represent vaccines. By decreasing order of priority, they are: A pharmaceutical code, CNK; ATC; A Vaccinnet specific code
Other terminologies used	No other terminology has been identified.
Rendering for citizens	According to the walkthrough described at https://www.roeckoe.be/?p=682, accessibility seems less than optimal. Once access has been attained the list of vaccines is presented with administration date, brand name and dose, and target diseases (taken from user manual, version 6.0 of May 2016). (see Figure 5) 
Sources	https://www.vaxinfopro.be/spip.php?article1461) https://www.vitalink.be/vaccinatiegegevens-delen https://www.vitalink.be/sites/default/files/atoms/files/Safe_Cookbook_Vaccinaties_v4.pdf https://www.ehealth.fgov.be/standards/kmehr/en/transactions/vaccination-report https://www.smals.be/fr/content/kmehr https://en.wikipedia.org/wiki/KMEHR https://www.roeckoe.be/?p=682

Table 39. Belgium

By selecting a row, additional information is unfolded, with the vaccine code and the administration date again. The user can obtain a PDF printout.

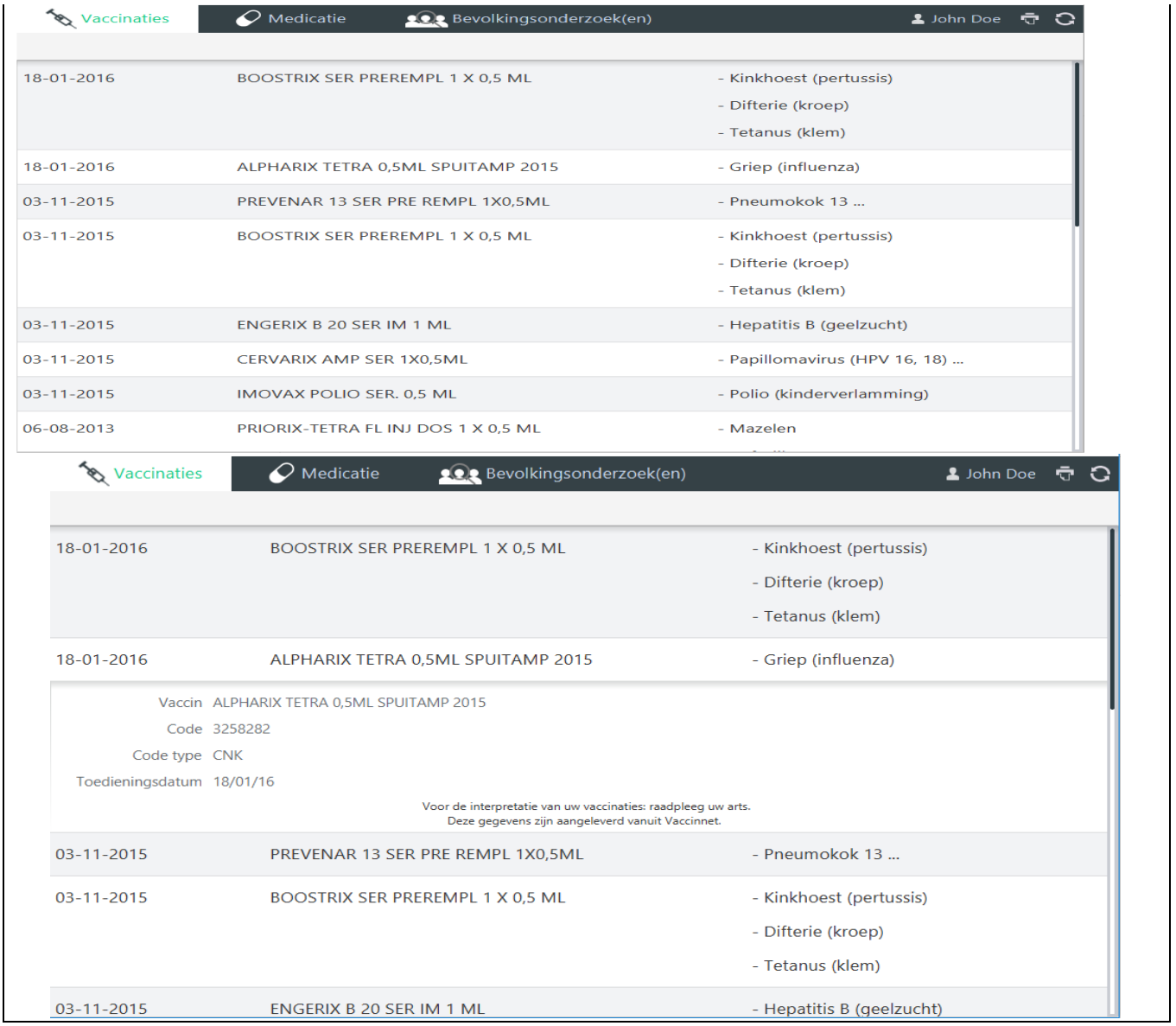


Figure 5. Rendering of the Belgian system

1.4.3. Bulgaria

A paper published in 2015[1] that provides an overview of Bulgarian e-Health states that the creation of an EHR for each Bulgarian citizen will be undertaken within the next five years, and that it will be accessible through a national e-Health portal that should be be opened in 2019. The site ehealth-bg.org of the e-Health Bulgarian foundation quoted in this paper is no longer accessible.

In June 2019, within a survey driven by EU JAV WP5, Bulgaria confirmed that they had not implemented an IIS.

1.4.4. Croatia

Summary	In September 2019, within a survey driven by EU JAV WP5 (personal communication), Croatia indicated that they had not implemented an IIS. Yet some information was found online: The Croatian Health Insurance Fund (HZZO) has set up a national EHR system named CEZIH. A patient portal eHZZO allows access to the stored data. At this stage it seems that vaccination information is not accessible, but discharge letters and prescriptions are.
Syntax	-
Citizen identity	The citizen is identified through their health insurance number (MBOO)
Vaccine designation	A specification document including the transaction for declaring adverse events mentions the substance code as coming from a Unique list of drugs (Jedinstvena lista lijekova). Most likely it uses the national

[1] Stanchev P. and Foteva E. Bulgarian E-Health Overview. DOI: 10.5220/0005889900870092. In Proceedings of the Fourth International Conference on Telecommunications and Remote Sensing (ICTRS 2015), pages 87-92

	pharmaceutical code.
Other terminologies used	-
Rendering for citizens	Not relevant yet.
Sources	https://www.hzzo.hr/ehzzo/ https://www.hzzo.hr/e-gradani/hzzo-za-e-gradane/

Table 40. Croatia

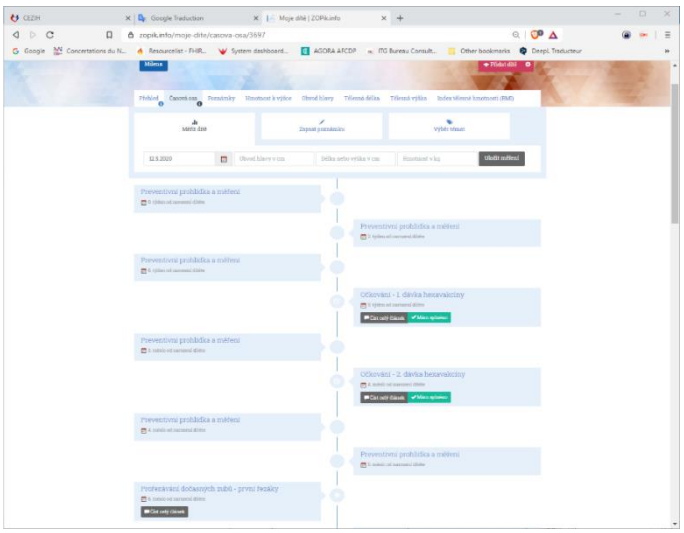
1.4.5. Cyprus

No IIS was found for Cyprus.

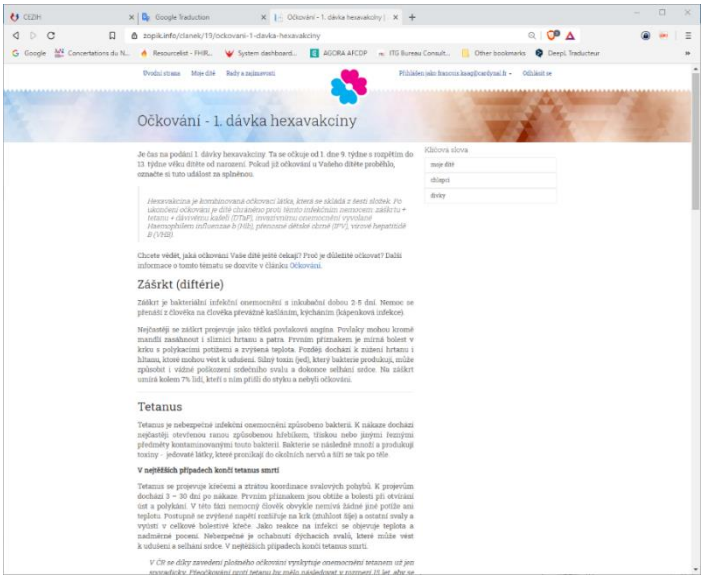
1.4.6. Czechia

Summary	A national eHealth strategy report was issued in 2016. It excludes the creation of a centralized information system by the state. Instead, eHealth is conducted through private initiatives with the government only having the role of orientation and urbanization. One of the objectives stated in the report is easy access to personal medical records by citizens, using a National Health Information Portal. A specific portal for child records exists at zopik.info. It allows individuals to record their vaccines and those of their children, and get recommendations for the next vaccinations. The application is self-contained and does not seem to exchange with third party systems. Thus, no technical specification was found on encodings.
Syntax	-
Citizen identity	-
Vaccine designation	-
Other terminologies used	-
Rendering for citizens	Recorded vaccination events are presented as a timeline of past and future vaccination events (Figure 6)
Sources	https://zopik.info/

Table 41. Czechia



By clicking on any vaccine event, the user is redirected to an information page on the vaccine and its administration scheme.



Outdated requested vaccinations are flagged in red until the user has clicked the “Done” checkbox or indicated that he wants to postpone for a few days.

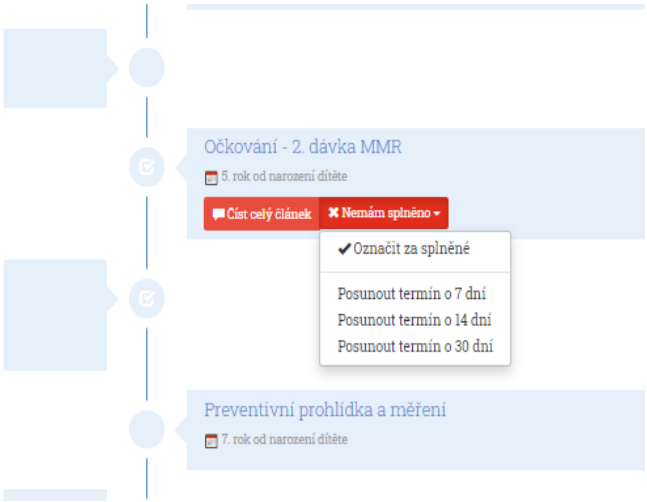


Figure 6. Rendering of the IIS for citizens in Czechia

1.4.7. Denmark

Summary	"Det Danske Vaccinationsregister" (DDV), theStatens Seruminstitut , is responsible for operating the DDV which contains all vaccinations since November 15th, 2015. To support it, access rights for health professionals were extended twice in 2017. Residents have access through portals (FMK-online.dk and Sundhed.dk) or a mobile application (Min Laege, that is ''My Doctor''). They can register their own vaccinations, for example when performed abroad.
Syntax	The standard for interaction is defined for the Faelles MedicinKort (FMK – Shared Medicine Card) as a set of Web services to handle XML documents.
Citizen identity	Individuals are identified with his civil registration identifier, a 10 digit number consisting of his birthdate and a sequence number.
Vaccine designation	The data structure for representing vaccines, diseases and vaccination plans is provided in Figure 7. A vaccine here is the link between a single drug and one or several diseases. Details of each table can be found at: https://www.nspop.dk/pages/releaseview.action?pageId=66414473. Each vaccine is uniquely identified with a Vaccine ID specific to the dataset, and characterized with an ATC Code, validity intervals, its name and potential synonyms, a description as a string of valences (e.g. Di-Te-Ki-Pol-HepB). Several vaccines can use a same ATC Code.
Other terminologies used	-
Additional information	For each vaccination: Report administrative details; Credibility of report (depending upon the origin and validation process); Batch number; Coverage duration; Dosage option; ConfirmedByPrescriptionServer; ActiveStatus; IsPrevious; NegativeConsentIndicator; Insurance and reimbursement details.
Rendering for citizens	Figure 8 illustrates the mobile application "Min Laege", a general-purpose application for interaction with health professionals (Q&A, videoconference, appointments, vaccinations, care plans …)
Sources	https://web.archive.org/web/20190803005619/https://sundhedsdatastyrelsen.dk/vaccinationsregister https://wiki.fmk.netic.dk/doku.php https://wiki.fmk.netic.dk/doku.php?id=fmk:ddv:1.4.0:getvaccinationcard https://wiki.fmk.netic.dk/doku.php?id=fmk:ddv:1.4.0:vaccine https://www.nspop.dk/pages/releaseview.action?pageId=66414473 https://minlaegeapp.dk/ https://sundhedsdatastyrelsen.dk/da/borger/selvbetjening_og_services/min_laege_appen

Table 42. Denmark

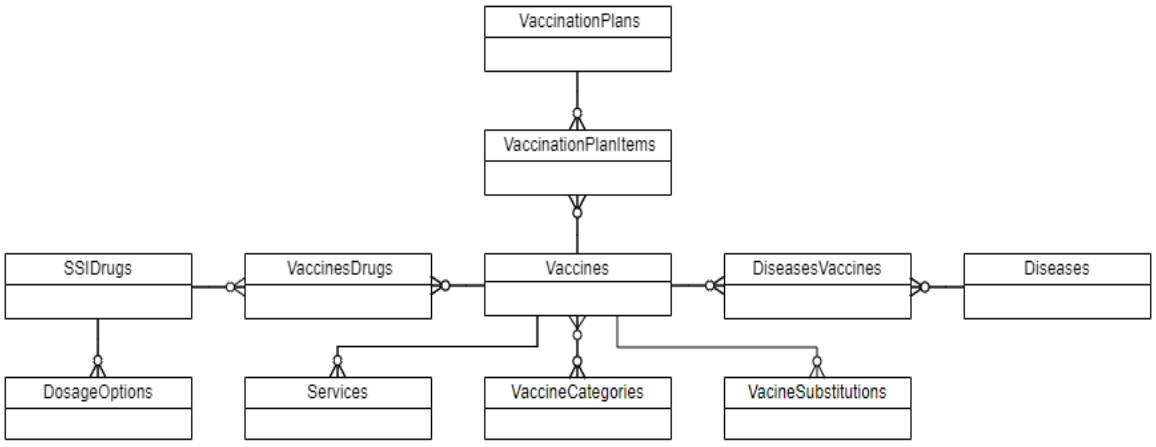


Figure 7. Vaccine designation in Denmark.

The Web application screen presents as follows:

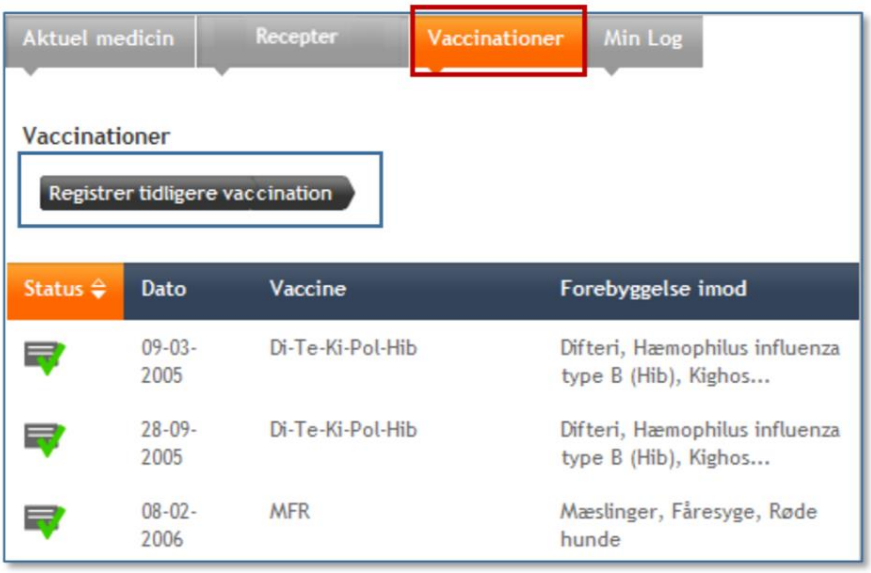


Figure 8. Rendering for citizens in Denmark

1.4.8. Estonia

Summary	The Estonian administration is highly digitized. Citizens can access their health records through the ePatient portal at https://www.digilugu.ee/ yes access to vaccination records appears to be incomplete (see https://news.err.ee/1054714/end-date-for-digitalization-of-vaccination-information-still-unclear)
Syntax	CDA formats have been defined for the notification of a newimmunisation event and for a completeimmunisation passport. Samples and style sheets are available in the study database, including a sample translated from Estonian to English. Most OIDs identifying the data items are taken under the IANA Private Enterprise Number (PEN) of the Estonian e-Health Foundation (1.3.6.1.28284).
Citizen identity	Composed of an OID for the national authority (typically Estonia) and a personal identification number, complemented with given name and family name.
Vaccine designation	The vaccine product may be identified by its ATC code and by its brand name
Other terminologies used	SNOMED-CT is used to identify the data element for next immunisation.
Additional information	For each immunisation event the following are recorded: Target diseases (one or several, national encoding); Batch number; Dose; Dose rank; Performing entity and person (including an external reference to a descriptive document); Planned date for next immunisation if any.
Rendering for citizens	No screen capture was found.
Sources	https://www.digilugu.ee/ http://web.archive.org/web/20190905203922/https://pub.etervis.ee/ https://news.err.ee/1054714/end-date-for-digitalization-of-vaccination-information-still-unclear

Table 43. Estonia

1.4.9. Finland

Summary	The National Institute for Health and Welfare (THL) operates an IIS that is fed by local EHR systems from the public sector (predominant in Finland) through the AVOHILMO infrastructure. Citizen access should be opened in the future through the My Kanta Pages (Omakanta) portal.
Syntax	My Kanta Pages content will be made available through FHIR webservices.
Citizen identity	The citizen is identified through their nationwide personal identity number.
Vaccine designation	The vaccine is identified by an application specific code, complemented by brand name, generic name, ATC code, and pharmaceutical code (Nordic Article Number). The list of codes is available at https://koodistopalvelu.kanta.fi/codeserver/pages/classification-view-page.xhtml?classificationKey=1925&versionKey=2185
Other terminologies used	None were identified. For each administered vaccine: Batch number; Vaccination route; Vaccination site; Target diseases
Rendering for citizens	Vaccination information in Kanta Pages is currently accessible by selecting 'Vaccination events' from a list of all recorded medical encounters. No screen capture was found.
Sources	Introduction: https://thl.fi/en/web/vaccination/vaccination-coverage/national-vaccination-register Overview: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2017.22.17.30520 HILMO documentation: http://www.julkari.fi/handle/10024/137178 Code system: https://koodistopalvelu.kanta.fi/codeserver/pages/classification-view-page.xhtml?classificationKey=1925&versionKey=2185 Instructions for recording: https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/tietoa-rokotuksista/rokottamisen-vaiheet/rokotusten-kirjaaminen Citizen access: https://www.kanta.fi/en/web/guest/my-kanta-pages

Table 44. Finland

1.4.10. France

Summary	Until now, the MesVaccins.net platform created and operated by SYADEM is the reference solution and has been subscribed by the health professional associations for several regions. Since May 2020, the possibility to register and view vaccination events has been added to the national EHR, Dossier Médical Partagé (DMP). Agence Numérique en Santé (ANS), formerly known as ASIP Santé, the governmental agency in charge of interoperability and standardization, has created a CDA template in collaboration with the MesVaccins team, as well as a FHIR specification to obtain vaccine recommendations from the MesVaccins recommendation engine. Note that the encodings chapter is based upon this standardization effort, while the Rendering is the one of MesVaccins. A mobile application named MesVaccins is also available.
Syntax	The dVC is a CDA document (profile Patient Care Coordination/Immunization Content). The link for its full specification is available in Sources below.
Citizen identity	The citizen is identified through a national health identifier, that is incidentally identical to social security number. It is complemented with name, surname, gender, birthdate, birthplace, address, and telephone number.
Vaccine designation	In the current version, the vaccine is identified with: The dispensation code (UCD) if it was administered within a hospital; The pharmaceutical code (CIS/CIP) if it was administered by a general practitioner, nurse, pharmacist, etc; The ATC code if it was administered abroad, and for future vaccinations. There is an ongoing effort to include the much more extensive NUVA terminology of MesVaccins within national terminologies. For now, data entry from a legacy VC is practically impossible due to a lack of appropriate codes.
Other terminologies used	LOINC and SNOMED-CT are used to characterize nodes in the CDA structure. LOINC is used for vital signs. ICD-10 is used for target diseases, past diseases, and adverse events.
Additional information	Other than the standard CDA headers (custodian, author, authenticator, encounter, etc.), there are many sections describing relevant factors for determining the vaccination decision: Past illnesses; Chronic diseases; Ongoing medications; Vital signs; Allergies; Pregnancy history; Social history; Refusal of vaccination. For each performed vaccination (Figure 9), the record contains: Performer, author; Route and site of administration; Dose quantity, dose rank; Batch number; Observed adverse effects. Recommended vaccinations (Figure 10 and Figure 11) are included with the target date, ATC code, route and site of administration, dose quantity and dose rank. Citizens can choose to share their information with health professionals (Figure 12).
Rendering for citizens	In MesVaccins Within a familial account, there are several cards. Each card his presented with four tabs (Figure 23).
Sources	https://esante.gouv.fr/sites/default/files/media_entity/documents/CI-SIS_CONTENUS_VOLET-VACCINATION_V3.1.pdf

Table 45. France

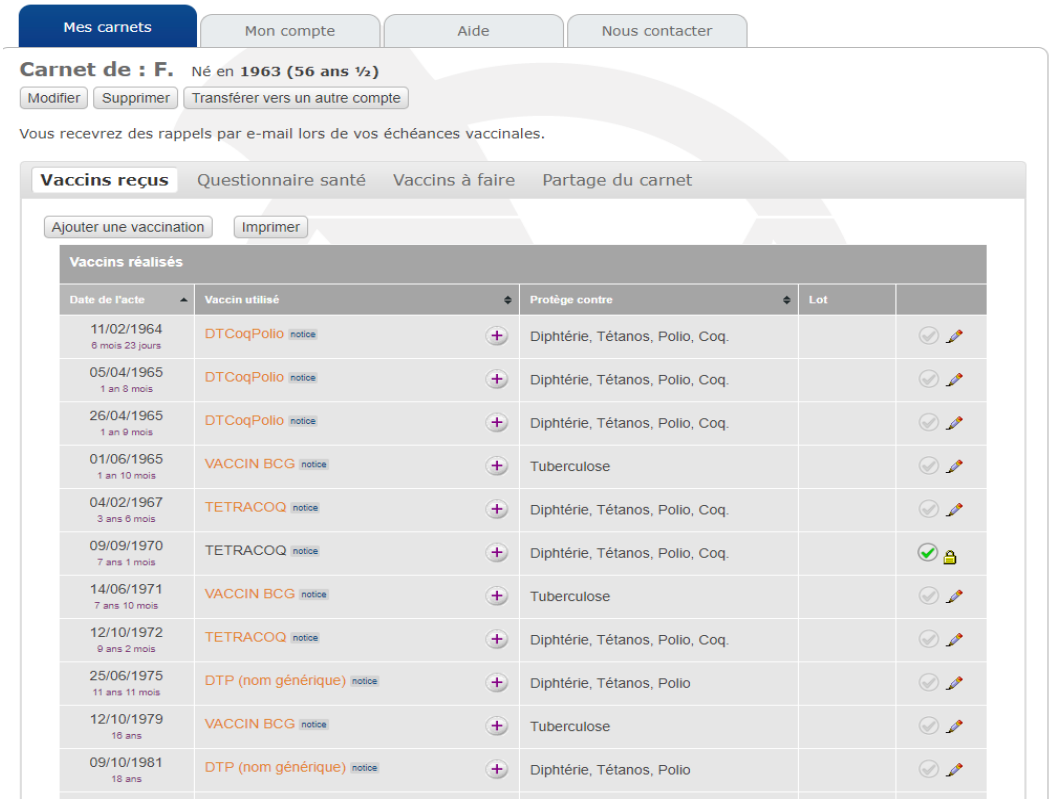


Figure 9. Performed vaccines

Figure 10. Conditions for recommendations

Figure 11. Actual recommendations

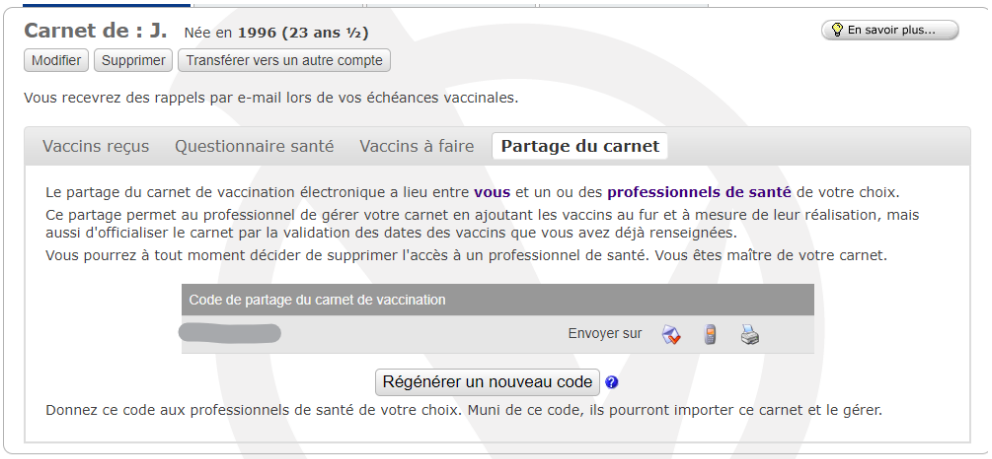
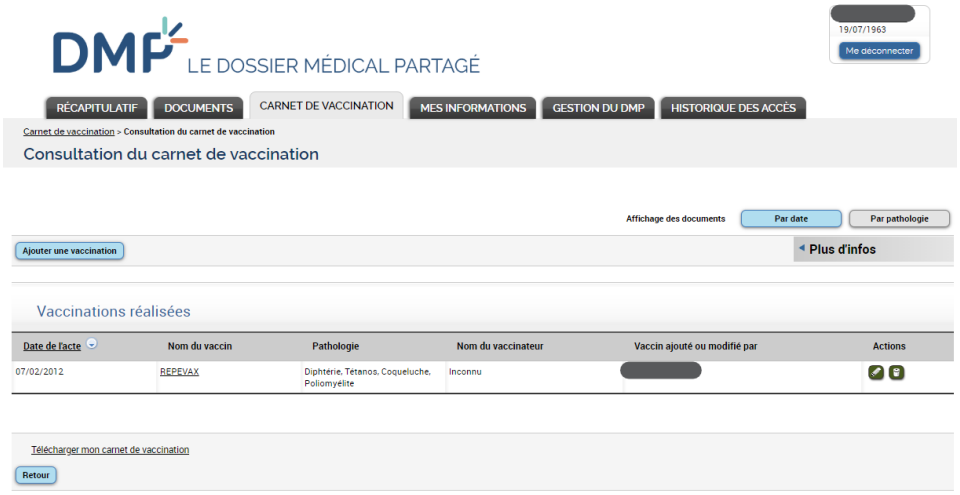
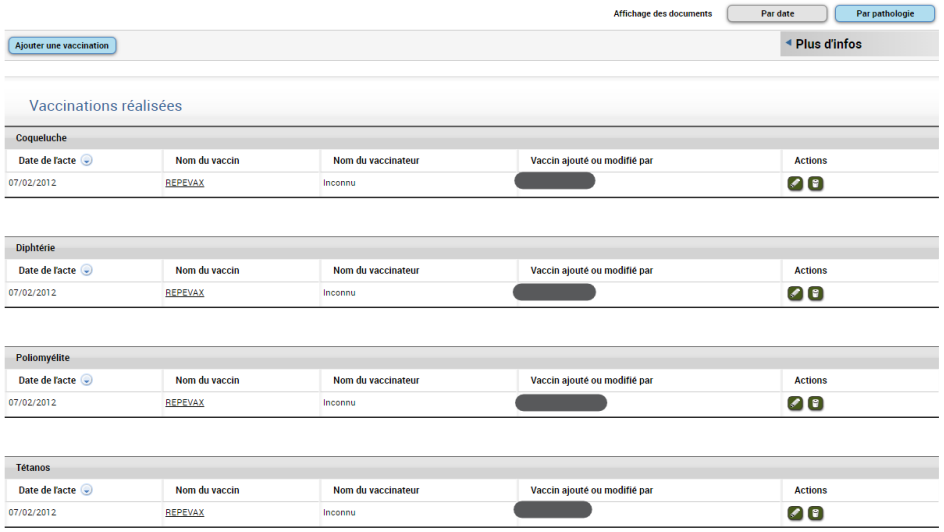


Figure 12. Control of shares with health professionals

View per date



View per target disease



Input of a vaccination event (by the citizen)

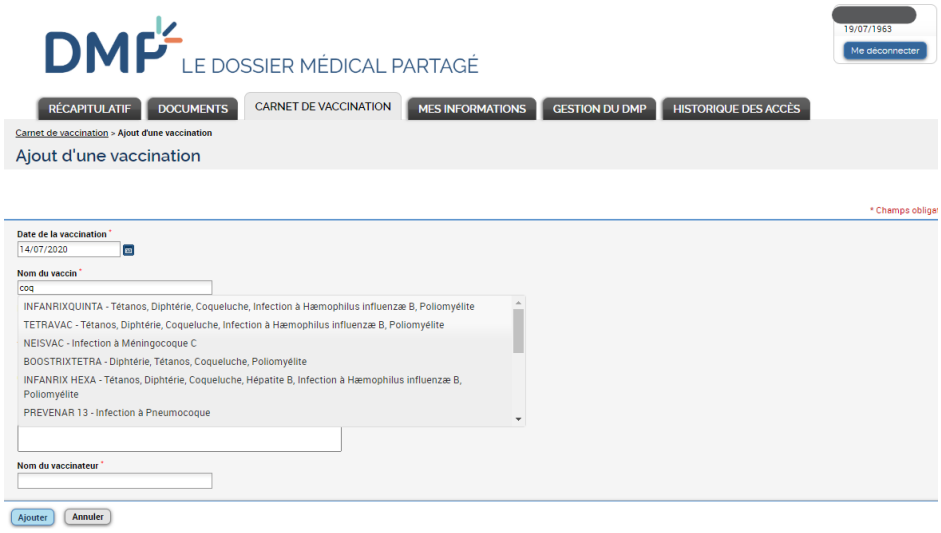


Figure 13. Rendering for citizens – DMP

1.4.11. Germany

There is no evidence of an IIS in Germany. The closest equivalent is the population monitoring tool KV-Impfsurveillance developed by the Robert Koch Institute, but it handles only pseudonymised data.

1.4.12. Greece

Summary	In September 2019, within a survey driven by EU JAV WP5 (personal communication), Greece confirmed that they had not implemented an IIS. Home information was found online however, and is presented here.
Syntax	Citizens have access to their e-health records through website e-syntagografisi.gr. It is a comprehensive set of information with their caregiver list, management of access rights, diseases, allergies, social habits (profession, smoking, alcohol), growth graphs … and vaccination. No technical information was found on the encodings that could be used to exchange with other systems.
Citizen identity	-
Vaccine designation	-
Other terminologies used	-
Rendering for citizens	Two tables list the vaccination dates, one for adult vaccines, the second one for children vaccines. A third one allows to enter free text for other vaccinations (Figure 14)
Sources	Citizen portal (e-prescription): https://www.e-syntagografisi.gr/p-rv/p

Table 46. Greece

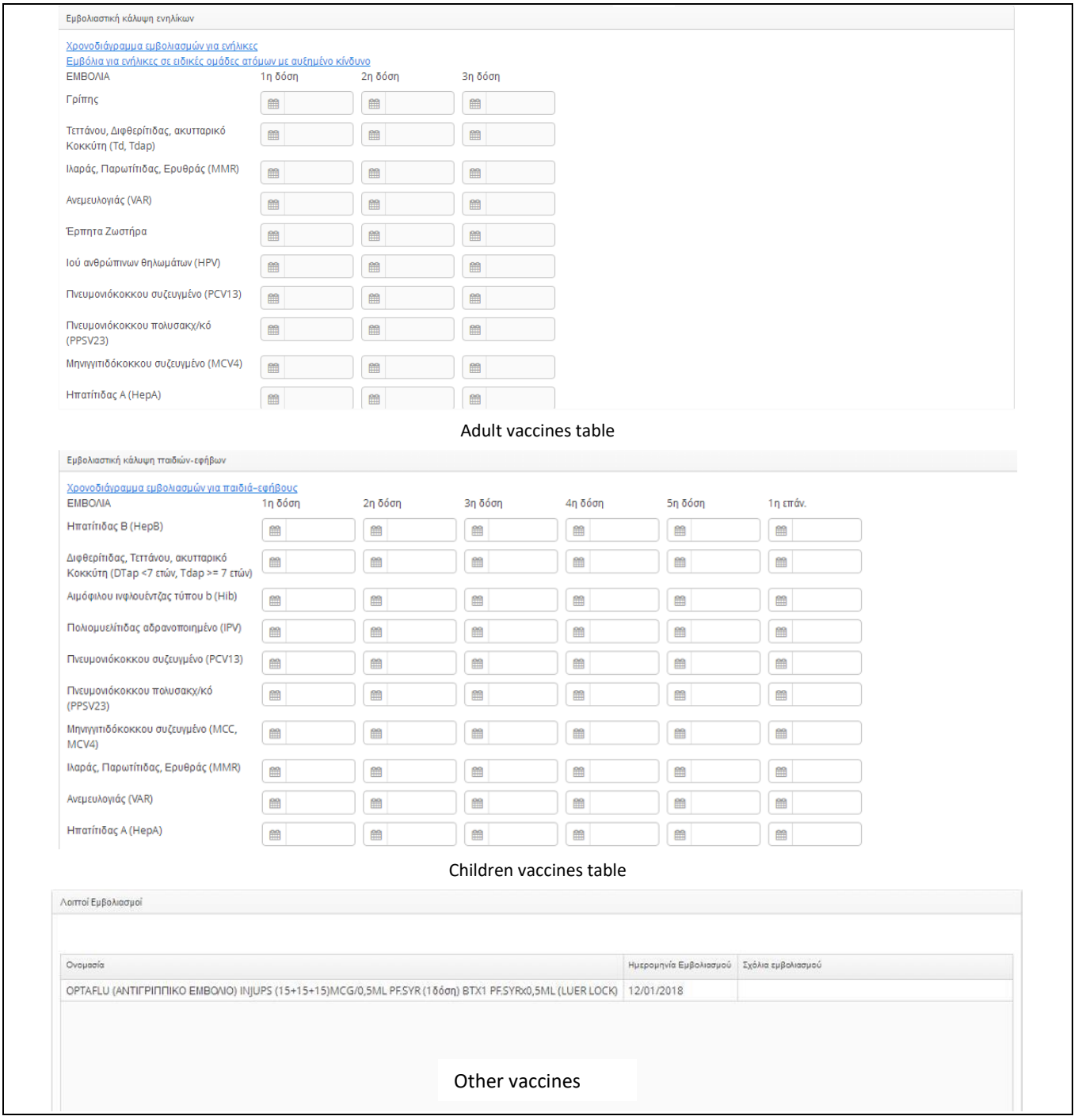


Figure 14. Greece, rendering for citizens

1.4.13. Hungary

Summary	The national eHealth database was launched in November 2017. It is accessible to citizens through a Patient Portal. Its module eProfile embeds the long-term medical records, including the vaccination history. No technical information was found on the encodings used to exchange with other systems. A request was sent to the infrastructure technical support on May 13th and was not answered yet.
Syntax	-
Citizen identity	-
Vaccine designation	-
Other terminologies used	-
Rendering for citizens	No screen layout was found for vaccinations. One for encounters is provided in Figure 15.
Sources	Presentation: https://e-egeszsegugy.gov.hu/hu/web/eeszt-information-portal/ Portal: https://www.eeszt.gov.hu/hu/nyito-oldal

Table 47. Hungary

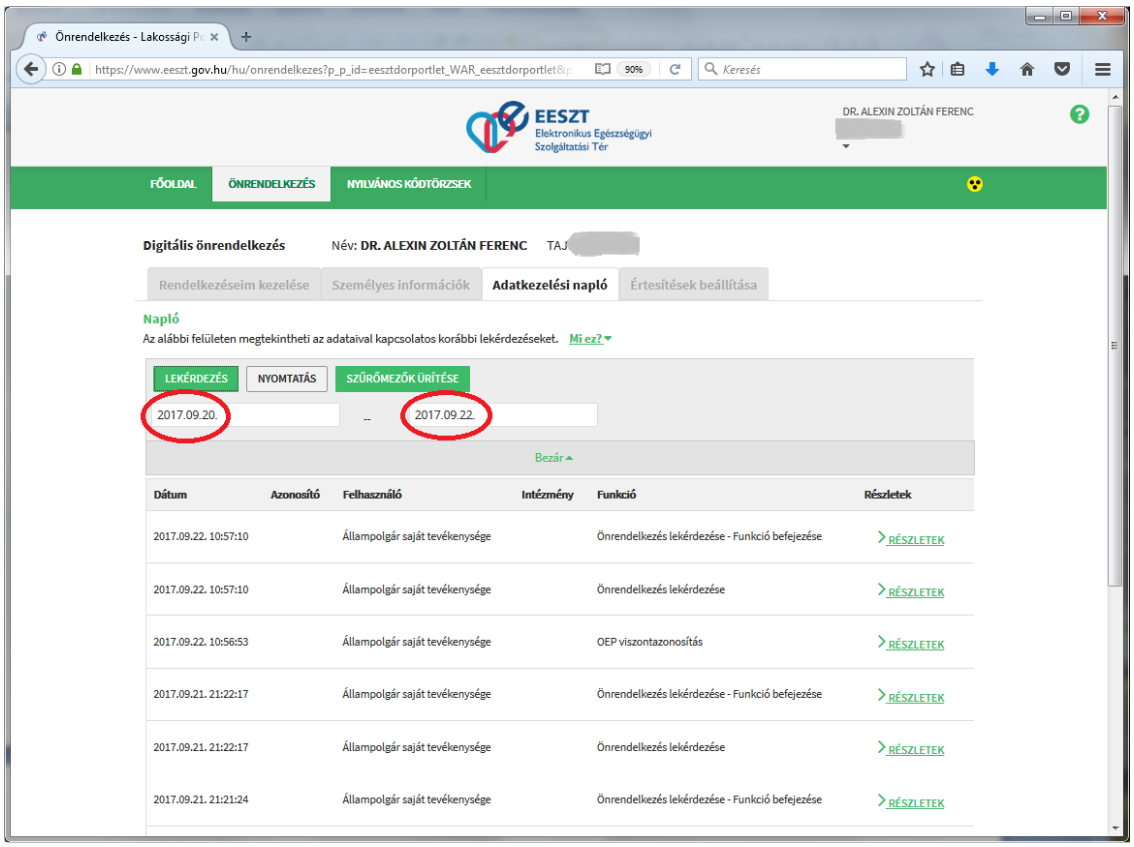


Figure 15. Encounters for vaccinations in Hungary

1.4.14. Ireland

Summary	A School Immunisation System exists, but no access is open to the citizens. A Child Immunisation Tracker service has been supported by the private company IrishHealth.com but has now been discontinued.
Syntax	-
Citizen identity	-
Vaccine designation	-
Other terminologies used	-
Rendering for citizens	-
Sources	http://www.irishhealth.com/hold/index.html

Table 48. Ireland

1.4.15. Italy

Summary	Italy is currently implementing a national system, "Anagrafe nazionale vaccini" (ANV) (National vaccines registry) to gather and consolidate information from the regional information systems. Although it is updated only once per quarter, the encodings used are relevant for a VC.
Syntax	The transfer syntax is a custom XML, with three files representing: The demographic situation of the source region; the administered vaccines; and the non-administered vaccines. The corresponding XML schemas can be found at the site referenced in Sources.
Citizen identity	Registered Italian citizens are identified with their fiscal identifier (Codice fiscale). Alternative methods are described for European citizens, either with the European Health Insurance Card number or specific codes for temporary residents or refugees. In the flow sent to the national system, the identifier is encrypted. Additional information includes gender, birth date, city of registration and of residence, and nationality.
Vaccine designation	Vaccines are identified with their Italian market authorization code (AIC), or from a list of foreign vaccines available at: http://www.dati.salute.gov.it/dati/dettaglioDataset.jsp?menu=dati&idPag=23. Their description also includes the brand name, number of antigens, individual antigens (actually, one record is created for each antigen, meaning for example that 4 records are transmitted for a tetravalent vaccine), batch number and vaccine expiry date.
Other terminologies used	None
Rendering for citizens	Not relevant
Additional information	Vaccination health facility; Health conditions at risk; Administration way and site; Dose rank; Payment conditions; Reason for non-vaccination
Sources	http://www.salute.gov.it/portale/vaccinazioni/dettaglioContenutiVaccinazioni.jsp?lingua=italiano&id=5067&area=vaccinazioni&menu=vuoto

Table 49. Italy

1.4.16. Latvia

In June 2019, within a survey driven by EU JAV WP5, Latvia confirmed that they had no IIS implemented.

1.4.17. Lithuania

Summary	In July 2019, within a survey driven by EU JAV WP5, Lithuania replied that they had not implemented an IIS, yet detailed technical information was found online and is presented here. Lithuania has deployed ESPBI, a national health information system. A patient portal is accessible at https://www.esveikata.lt/
Syntax	ESPBI is exposed as a collection of FHIR resources. Documents are constituted as FHIR bundles (Atom feeds). Specifically, the E063 bundle forms a vaccination statement. The FHIR resources Immunization and ImmunizationRecommendation, such as described at http://hl7.org/fhir, are used.
Citizen identity	It is a detailed FHIR object, including the national identity number.
Vaccine designation	Vaccines are encoded using the pharmaceutical code NPAKID-7 and NPAKID.
Other terminologies used	As described in the FHIR resources.
Additional information	As defined in the FHIR Immunization resource: batch number, administration route and site, performer, adverse events, protocol applied, dose number, vaccine expiration date.
Rendering for citizens	The “Skiepy kalendorius” portlet redirects to the next vaccinations (Figure 16).
Sources	Technical documentation: https://www.esveikata.lt/naujienos/0/21 Professional view: https://specialistas.esveikata.lt/help/index.html?page=perzireti-skiepu-irasus-kalendoriaus-forma.html

Table 50. Lithuania

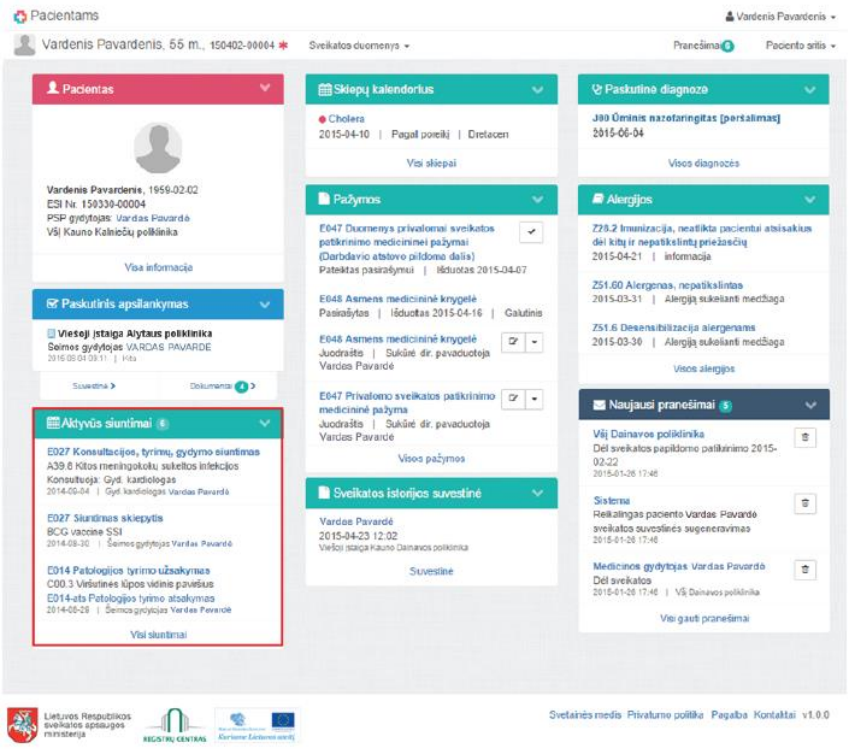


Figure 16. Rendering for Lithuania

1.4.18. Luxemburg

In a feedback e-mail sent on 28 April 2020, the Luxemburg eHealth agency confirmed that they were working on a dVC and had elaborated a proof of concept. Further demands for details were unsuccessful.

1.4.19. Malta

Summary	MyHealth is a national EHR for patients and doctors. It gives access to discharge letters, biology reports, medical imaging, appointments, patient summary. The vaccination report in the MyHealth portal shows vaccinations given by the National Immunisation Service since 1990, including those given from Health Centres and reported by private doctors, but excluding seasonal influenza vaccinations at Health Centres and tetanus vaccines given at Mater Dei or Health Centre emergency rooms. Patients who have old vaccination records may send them to the Government Immunisation Unit (immunisation@gov.mt) for inclusion.
Syntax	Malta was leading the patient summaries activity in the EU funded project epSOS, and thus uses CDA for international exchanges, but there was no evidence found about their local usage.
Citizen identity	The citizen is identified with his e-ID card.
Vaccine designation	From the presentation done at the ANTILOPE meeting of June 2014 and the screen capture that shows a very limited level of precision, the codification is most likely pure ATC.
Other terminologies used	No details found
Rendering for citizens	See Figure 17
Sources	https://myhealth-ng.gov.mt/

Table 51. Malta

Search: From: dd/mm/yyyy To: dd/mm/yyyy

Show only administered Show only scheduled

Save as PDF | Save as CSV | Report a Vaccination | Clear All Filters

Date administered	Vaccinations	Dose No.	Location of vaccination	Scheduled/Administered
18/04/2001	DIPTHERIA, TETANUS, PERTUSSIS	1	GZIRA HEALTH CENTRE	Administered
18/04/2001	HIB (HAEMOPHILUS TYPE B INFLUENZA)	1	GZIRA HEALTH CENTRE	Administered
18/04/2001	POLIO	1	GZIRA HEALTH CENTRE	Administered
26/07/2001	DIPTHERIA, TETANUS, PERTUSSIS	2	GZIRA HEALTH CENTRE	Administered
26/07/2001	HIB (HAEMOPHILUS TYPE B INFLUENZA)	2	GZIRA HEALTH CENTRE	Administered
26/07/2001	POLIO	2	GZIRA HEALTH CENTRE	Administered
14/11/2001	DIPTHERIA, TETANUS, PERTUSSIS	3	GZIRA HEALTH CENTRE	Administered
14/11/2001	HIB (HAEMOPHILUS TYPE B INFLUENZA)	3	GZIRA HEALTH CENTRE	Administered
14/11/2001	POLIO	3	GZIRA HEALTH CENTRE	Administered
25/02/2003	MEASLES, MUMPS, RUBELLA (MMR)	1	MOSTA HEALTH CENTRE	Administered
22/02/2005	DIPHTHERIA, TETANUS	4	MOSTA HEALTH CENTRE	Administered
22/02/2005	POLIO	4	MOSTA HEALTH CENTRE	Administered
08/10/2007	HEPATITIS B	1	SCHOOL MEDICAL SERVICE MALTA	Administered
12/11/2007	HEPATITIS B	2	SCHOOL MEDICAL SERVICE MALTA	Administered
14/04/2008	HEPATITIS B	3	SCHOOL MEDICAL SERVICE MALTA	Administered
29/01/2009	MEASLES, MUMPS, RUBELLA (MMR)	2	SCHOOL MEDICAL SERVICE MALTA	Administered

Figure 17. Rendering for Malta

1.4.20. Netherlands

Summary	A central immunisation registry has existed since 2005, called Praeventis. Citizens do not have access to Præventis but they are able to request information on their vaccination history at the local organisation responsible for the execution of the National Immunisation Programme (NIP) in their own region. Præventis provides vaccination status in real-time for every infant born or registered in the Netherlands: through a link with the population register (gemeentelijke basisadministratie, GBA), Præventis receives continuous updates on all newborn and deceased children and on changes in the address of children (due to movement within the country or immigration/emigration). At this stage, the Dutch IIS does not capture complete vaccination data for refugees, asylum seekers, and diplomats. Praeventis has a link to the population register; it receives continuous updates on all newborn and deceased children, and on changes in the addresses of children (due to change of address within the country or immigration/emigration). We did not obtain any encoding information on Praeventis.
Syntax	-
Citizen identity	-
Vaccine designation	-
Other terminologies used	-
Rendering for citizens	-
Sources	https://www.ncbi.nlm.nih.gov/pubmed/22551495

Table 52. Netherlands

1.4.21. Poland

No evidence was found of any IIS in Poland.

1.4.22. Portugal

Summary	In May 2020, Portugal announced the release of its vaccine register, eBoletim de vacinas (https://ec.europa.eu/regional_policy/pt/projects/portugal/vaccination-ecard-covers-all-portuguese-citizens). It is an additional service within a citizen health portal and mobile application MySNS Carteira.
Syntax	The system uses a FHIR STUv3 encoding with specific services to request for a vaccination schedule or a vaccination status. The answer consists of FHIR Immunization and Immunization Recommendation resources.
Citizen identity	The patient is identified with his national health number (SNS number). Optional additional information consists of name, gender, birth date, contact information and address.
Vaccine designation	Vaccines are represented with their Infarmed pharmaceutical code or a SNOMED-CT code, plus their description in English.
Other terminologies used	According to the specification of the FHIR resources.
Additional information	Health facility; Dose sequence; Target disease; Dose status (indicates if dose counts towards immunity); Vaccinator identity (practitioner).
Rendering for citizens	-
Sources	https://ec.europa.eu/regional_policy/pt/projects/portugal/vaccination-ecard-covers-all-portuguese-citizens https://www.sns24.gov.pt/servico/aceder-ao-boletim-de-vacinas-eletronico/

Table 53. Portugal

1.4.23. Romania

Summary	The Registrul Electronic National de Vaccinari (RENV) records since 2011 the vaccination for citizen under the age of 18. The database is updated monthly by maternity departments and family doctors. The reports generated by the system are submitted by the physicians to the District Public Health Authorities in order to obtain reimbursement for the services provided. The District Public Health Authorities have access to the National Electronic Vaccination Registry in order to verify the physicians' reports, as well as to generate analyses of vaccination coverage in their districts. No technical detail was found on encodings.
Syntax	-
Citizen identity	For each child registered in the system, the application generates a UNIQUE child identification code (CUI). It will later be replaced with the national identifier (CNP) Upon leaving the maternity ward, the parents will receive the file of the child on which they will be found and the unique registration code of the child in the system. At the first visit made to the doctor who will take care of the child's vaccination after leaving the maternity ward, the parents will present the child's file to the doctor. Based on the unique registration code generated by the system, the doctor will identify the child in the system and will fill in the child's CNP on his file. After completing the form with the CNP, the doctor will add the vaccines given to the child.
Vaccine designation	As described in the user manual, vaccines are identified by antigens and brand name. The list of presented vaccines is filtered according to the national vaccination plan and the administrations already performed.
Additional information	For each vaccination: batch number, vaccine expiration date, adverse events following immunisation, observations.
Other terminologies used	-
Rendering for citizens	-
Sources	https://insp.gov.ro/index.php/manuale-renv-maternitati-si-medici

Table 54. Romania

1.4.24. Slovakia

In September 2019, within a survey driven by EU JAV WP5, Slovakia confirmed that they had no IIS implemented.

1.4.25. Slovenia

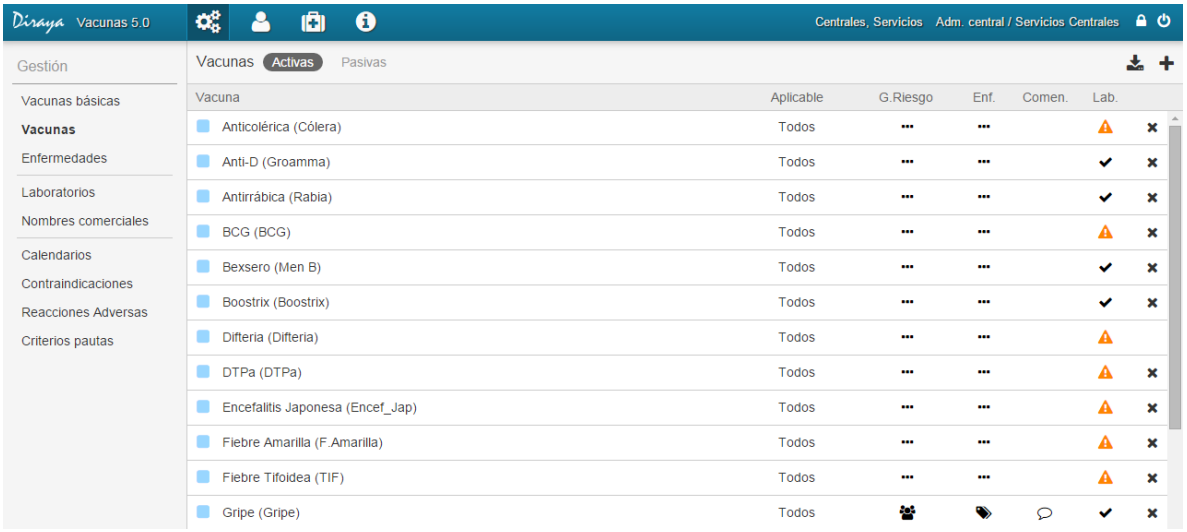
Summary	The Slovenia IIS, eRCO, has been deployed since 2017.
Syntax	-
Citizen identity	The citizen is identified with his health insurance number (ZZZS). Optionally, the national identification number (EMSO) can be used for children that do not have yet a health insurance number. His name, surname, sex, birth date, and address are also recorded.
Vaccine designation	Vaccines are represented with their national pharmaceutical code (CBZ), brand name, SNOMED-CT code and target diseases. CBZ is the most precise designation, several different entries use the same SNOMED-CT code.
Other terminologies used	SNOMED-CT is used for target diseases.
Additional information	For each administration: Batch number, dose rank per target disease, vaccination provider and facility, reason for vaccination, administration route and site, observations, adverse events following immunisation. For non-administered vaccines: reason for cancellation.
Rendering for citizens	-
Sources	https://nijz.si/sl/elektronski-register-cepljenih-oseb-in-nezelenih-ucinkov-po-cepljenju-erco

Table 55. Slovenia

1.4.26. Spain

Summary	Each of the 17 regions in Spain has its own IIS or EHR. Some information was found only on Diraya, the IIS for Andalusia.
Syntax	No exchange format was found.
Citizen identity	The citizen is identified with his 'Número Único de Historia de Salud de Andalucía' (NUHSA).
Vaccine designation	The application differentiates between individual antigens (Vacunas básicas) and actual vaccines, that can be target diseases (Gripe), groups of antigens (DTPa), or brand names (Figure 18).
Other terminologies used	No exchange format was found.
Additional information	From the printout, it appears that the batch number and health facility are recorded for every performed vaccination. From the configuration menus, there are tables for target diseases, laboratories, adverse effects, some criteria to select a vaccination scheme.
Rendering for citizens	A companion mobile application Vacunas can be used to view the contents (Figure 19).
Sources	https://play.google.com/store/apps/details?id=es.juntadeandalucia.msspa.appvacunas.android&hl=es https://www.sspa.juntadeandalucia.es/servicioandaluzdesalud/profesionales/sistemas-de-informacion/diraya

Table 56. Spain



Vaccine events are registered by target disease or group of target diseases, with several records when a multivalent vaccine is used.

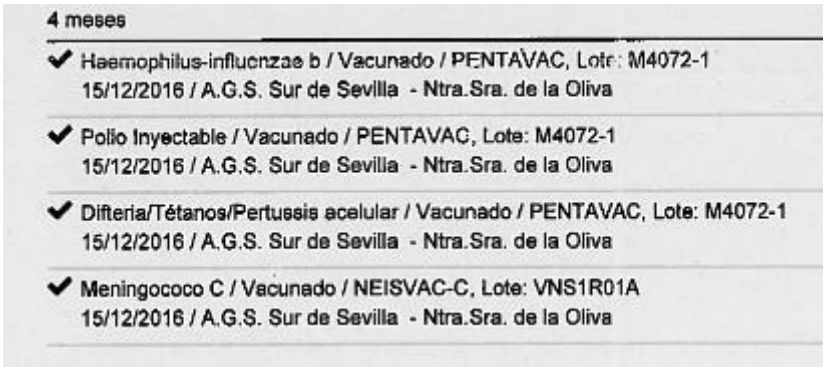


Figure 18. Vaccine designation

It is also possible to obtain a printout of the vaccination history.

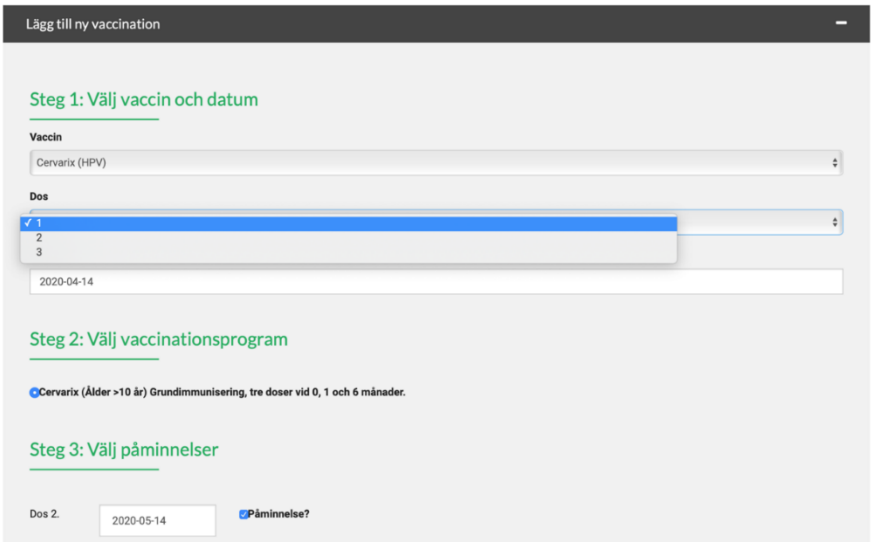
Figure 19. Rendering for citizens

1.4.27. Sweden

Summary	Since 2013, a national system (Nationella vaccinationsregistret) is fed for children vaccination for 11 target diseases. It is accessible to citizens A mobile application named MittVaccin is also available.
Syntax	No technical information was found on exchange formats.
Citizen identity	The person is identified with a national identification number. It is complemented with the residence at the time of vaccination, the current residence (updated daily from the tax register), the birth date, the gender.
Vaccine designation	Vaccines are encoded with a local identifier (NPL-ID), or if missing the brand name. The codes table is available online. The target disease is also specified, in full text
Other terminologies used	None were identified
Rendering for citizens	Account creation (Figure 20)
Sources	http://web.archive.org/web/20210115024828/https://vaccinationskortet.se/ https://www.folkhalsomyndigheten.se/smittskydd-beredskap/vaccinationer/vaccinationsregister/ https://www.folkhalsomyndigheten.se/contentassets/7e0f5d83310044868a7ef582078cbe76/nvr-variabellista.pdf

Table 57. Sweden

Recording a vaccine administration:



Vaccines choice:

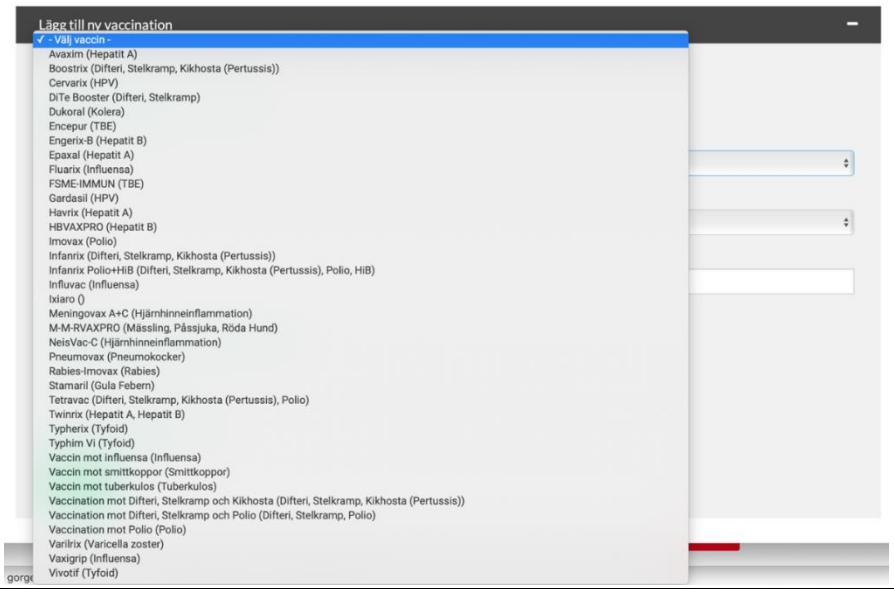


Figure 20. Rendering for citizens in Sweden

1.4.28. United Kingdom

Summary	NHS has subcontracted to Sitekit Ltd an application, eRedBook, fed since August 2019 from the immunisation events flowing through the NHS National Event Management Service (NEMS). Other sources that do not feed the NEMS may also connect directly to the eRedBook infrastructure.
Syntax	
Citizen identity	Citizens create their eRedBook account with their e-mail address or Facebook account. The association between a child NHS identity and an eRedBook account is made by a health professional upon request of the eRedBook account owner. The national NHS identifier is used, complemented with the gender and date of birth.
Vaccine designation	NHS has created a local extension “UK drug extension module” to SNOMED-CT in order to represent the vaccines.
Other terminologies used	-
Rendering for citizens	See Figure 21.
Sources	http://web.archive.org/web/20200806091701/https://support.eredbook.org.uk/knowledgebase/category/?id=CAT-01021 https://termbrowser.nhs.uk/?perspective=full&conceptId1=71181003&edition=uk-edition&release=v20200610

Table 58. United Kingdom

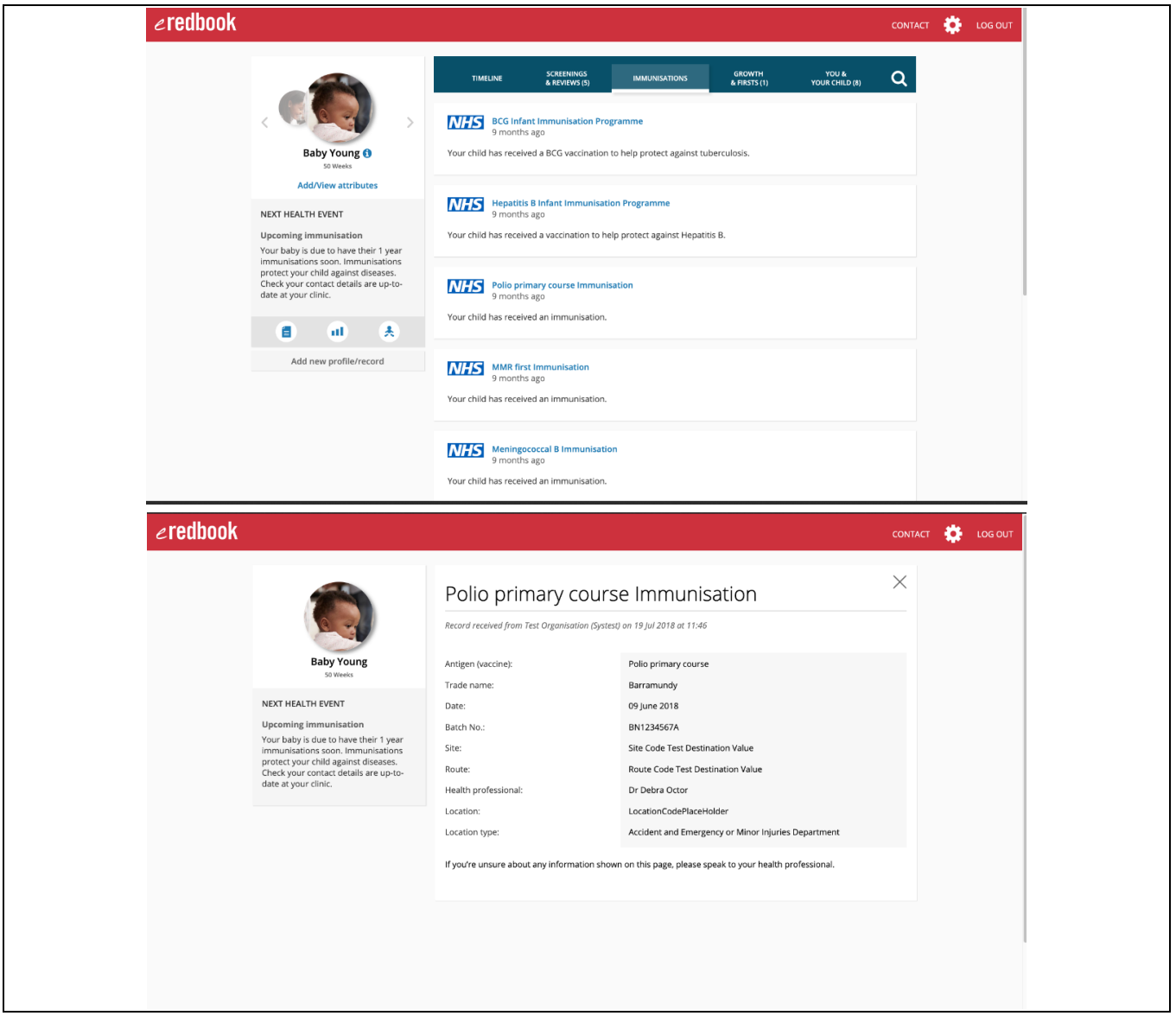


Figure 21. Rendering for citizens in the UK

1.4.29. United States of America

Summary	There are 63 identified IIS in the USA. The American Immunization Registry Association gathers all of them and publishes useful analysis and guidelines. The data is this sheet comes from the AIRA website. (Figure 22). The MIROW (Modeling of Immunization Registry Operations Workgroup) establishes best practice guides for all operational aspects of IIS. Various citizens portals, such as https://myvaccinerecord.cityofnewyork.us/ , allow access to personal records.
Syntax	The HL7v2 Immunization messaging is enforced for exchange of data between EHRs and IIS. A full specification is available from the AIRA website.
Citizen identity	The patient identification is specific to each IIS. The exchange specification refers to the existence of identity brokers for reconciling the systems.
Vaccine designation	AIRA released an excellent synthesis of Vaccine Code Set Considerations (18) on May 21st, 2020. The US CDC manages and publishes his own code sets, the CVX codification of vaccines and the MVX codification of manufacturers. It is complemented as usual by the pharmaceutical code (NDC) and the brand name. The responses to the survey done in this study are provided in Table 60. The study stresses on the need for an automated distribution and integration of code sets. The CDC VCSMS (Vaccine Code Sets Management Service) is designed to serve this purpose.
Other terminologies used	LOINC codes are used to characterize the HL7 message segments and provide further information of patient and context, a guidance document on their use is available from the AIRA website.
Rendering for citizens	See Figure 23.
Sources	https://repository.immregistries.org/resources/search/HL7/filtered/by/technical https://myvaccinerecord.cityofnewyork.us/myrecord/home.htm#

Table 59. United States of America

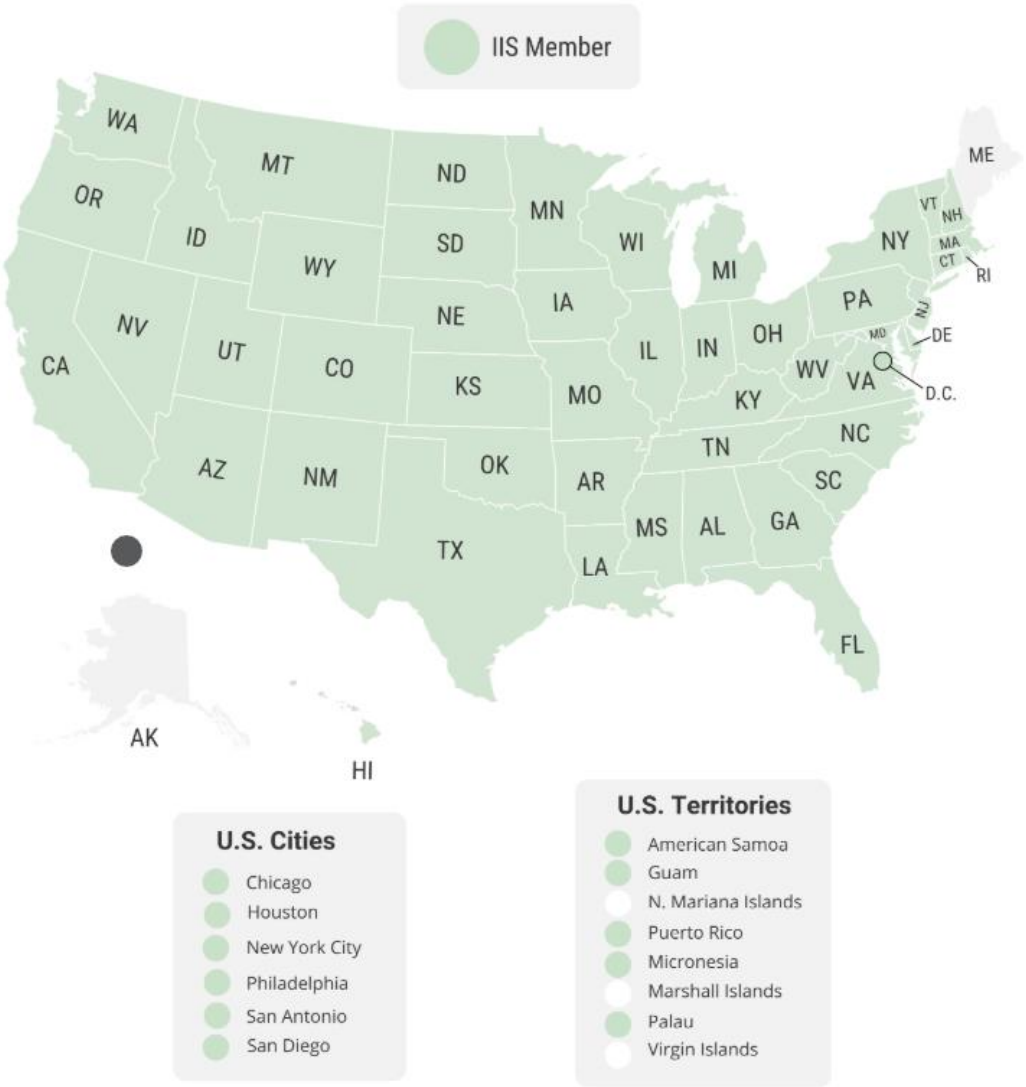


Figure 22. 63 IIS exist in the US.

Table	% of Respondents Referencing Its Use
CVX	89%
NDC Crosswalk	79%
Product Name Mapped to CVX/MVX	74%
MVX	68%
CPT Mapped to CVX	63%
CVX Mapped to Vaccine Group	53%

Table 60. Responses to the survey conducted by AIRA on vaccine code sets in the US

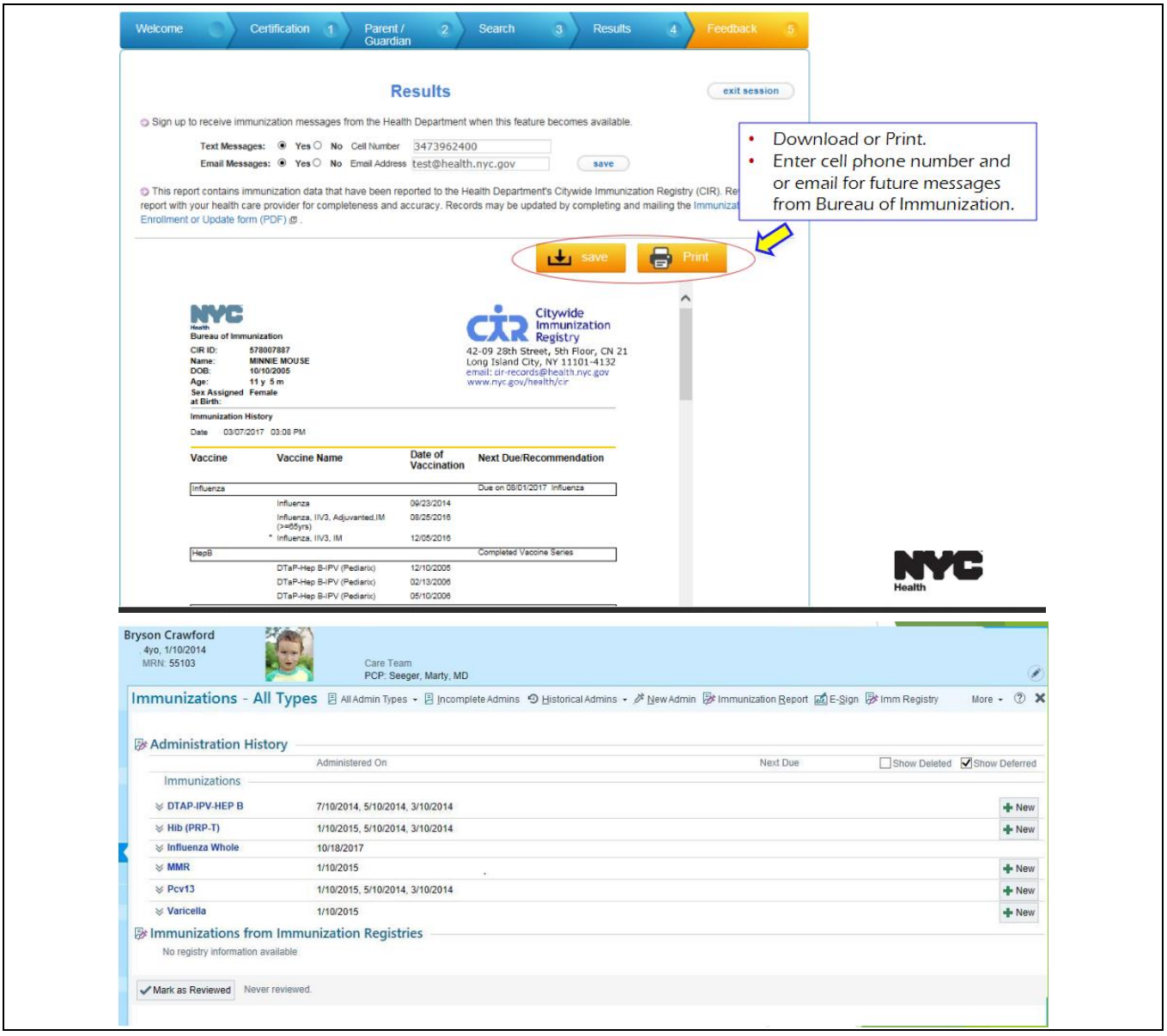
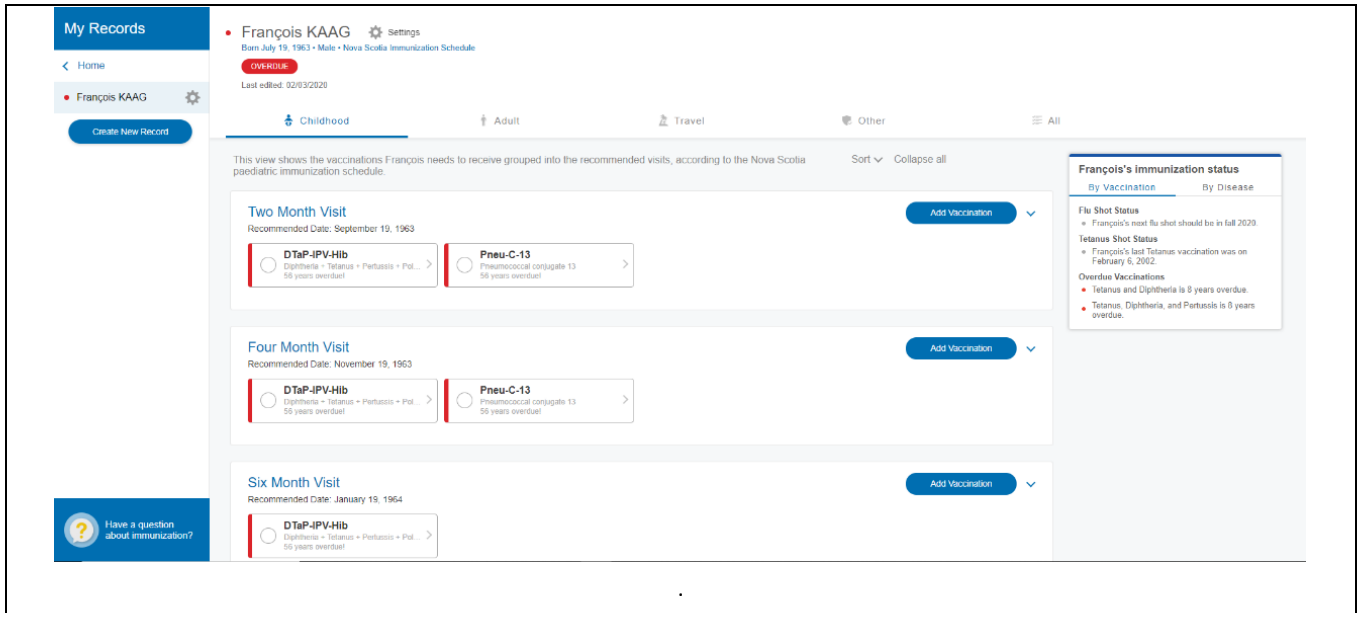


Figure 23. Rendering examples from the USA

1.4.30. Canada

Summary	Each province or territory in Canada is responsible for its organization of vaccinations and may have an IIS of its own. A common user portal and applications, CANImmunize (https://www.canimmunize.ca/), allows citizens to record by themselves their vaccines and check them against the schemes for their residence province. The data can be synchronized on a server with a CANImmunize account. In some provinces, the CANImmunize records can be transferred to the provincial IIS. No technical information was fond on transfer formats.
Syntax	-
Citizen identity	-
Vaccine designation	Vaccines are described according to the Canadian Vaccine Catalog (see documentation at https://cvc.canimmunize.ca/en/home).They are presented as a collection of valences. The brand name can be added as an extra characteristic for the vaccines that were commercialized in Canada.
Other terminologies used	SNOMED-CT is used for diseases and events categorization.
Rendering for citizens	Vaccines are organized with tabs: Childhood, Adult, Travel, Other and All. For the Childhood and Adult tabs, the scheduled routineimmunisation are presented by age, then recommended vaccine valences for each age. The user is free to remove or reschedule an event, and validate the sending of a notification on the due date. Vaccines are presented with a green, grey, or red border depending upon whether they are up to date, late or not recommended. Further details can be obtained by clicking on a given vaccine. Travel vaccinations and out-of-routine vaccinations are presented as a simple list. See Figure 24.
Sources	https://www.canimmunize.ca/ Vaccine catalogue: https://cvc.canimmunize.ca/en/home

Table 61. Canada



Pneumococcal Disease

Nova Scotia recommends this vaccine for those 65 years and older

Pneu-P-23
Pneumococcal polysaccharide 23
Recommended On July 19, 2028

Tetanus and Diphtheria

Nova Scotia recommends this vaccine is received every 10 years

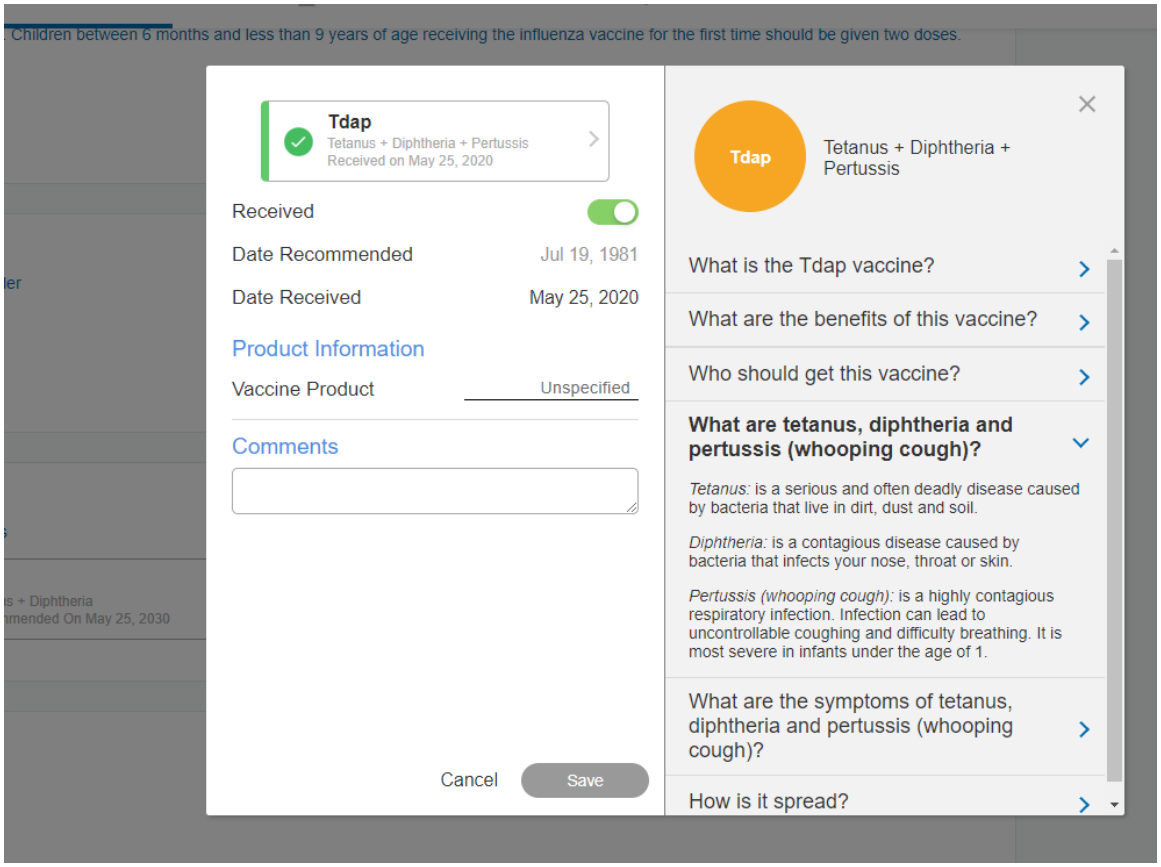
Td
Tetanus + Diphtheria
Scheduled for May 25, 2020

Td
Tetanus + Diphtheria
Recommended On May 25, 2030

Tetanus, Diphtheria, and Pertussis

Nova Scotia recommends one dose of the Tdap vaccine

Tdap
Tetanus + Diphtheria + Pertussis
Received on May 25, 2020



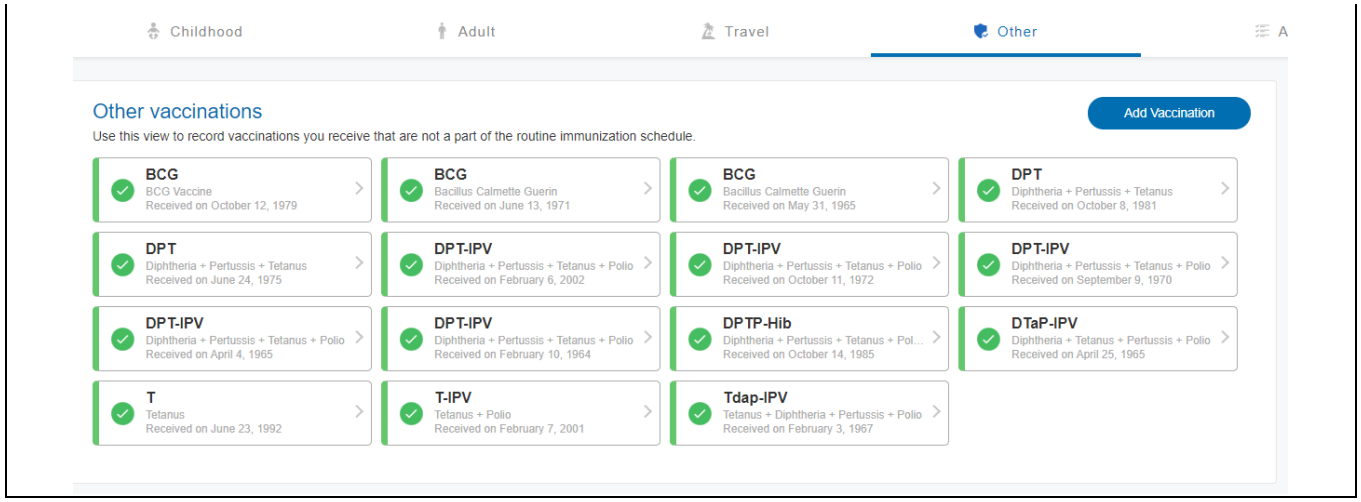
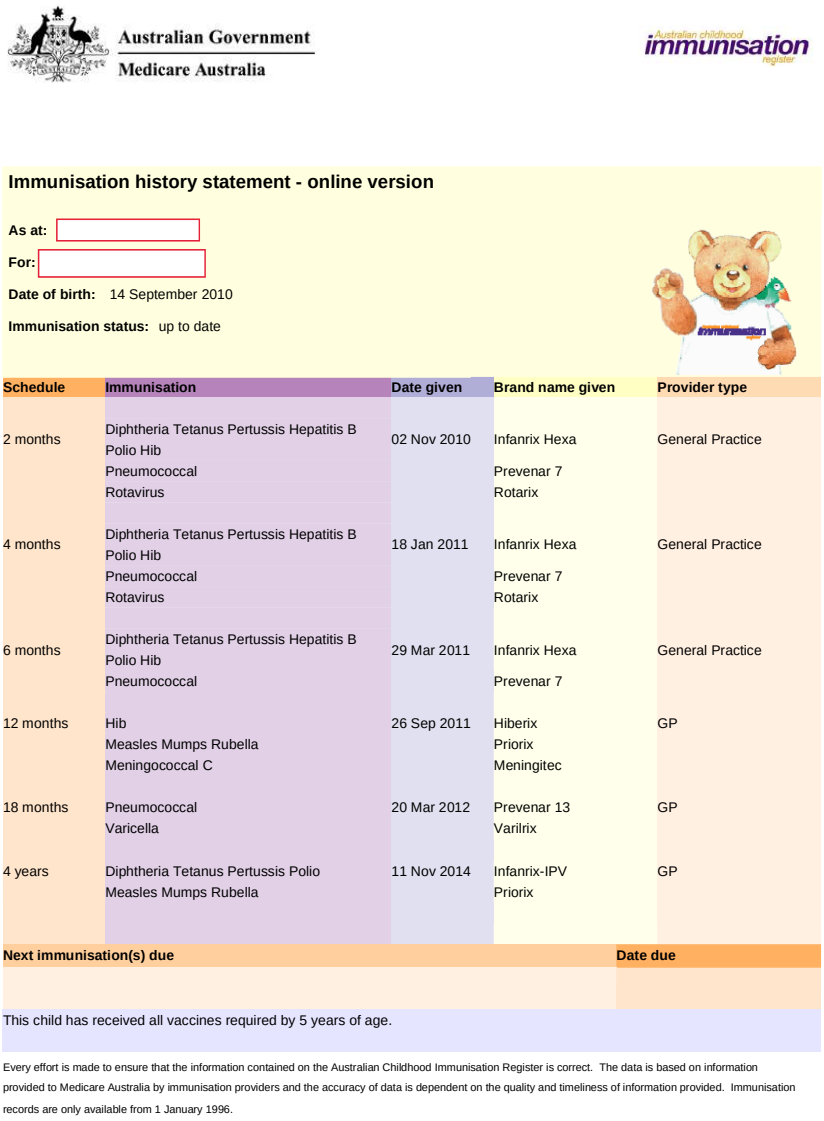


Figure 24. Rendering in Canada

1.4.31. Australia

Summary	The Australian Immunization Register (AIR) is a national register that records all vaccines given to all people in Australia. The AIR includes vaccines given under the nationalimmunisation program, through school programs, and privately, such as for flu or travel. Every citizen enrolled in Medicare has an AIR vaccination record. It is updated directly by the vaccination providers. Two mobile applications named “ExpressPlus Medicare” and “Save the Date to Vaccinate” are also available.
Syntax	The immunisation record is transferred to other applications as a CDA document. The full CDA documentation is in the referenced CDA implementation guide.
Citizen identity	Citizens are identified through their Individual Healthcare Identifier (IHI) https://www.servicesaustralia.gov.au/organisations/health-professionals/services/medicare/healthcare-identifiers-service-health-professionals/about/types-healthcare-identifiers#a1
Vaccine designation	The primary codification for Vaccine designation is the Australian Medicines Terminology (AMT). As a fallback, the application has its own vaccine code set, with codes per brand name, plus a few generic codes per target disease. The full code set is available at: https://www.servicesaustralia.gov.au/organisations/health-professionals/services/medicare/australian-immunisation-register-health-professionals/resources/air-vaccine-code-formats The vaccine entry may also include the list of antigens, represented through a custom CDA extension, and encoded with a Medicare antigen code.
Other terminologies used	SNOMED-CT is used for the CDA structure.
Additional information	The usual CDA headers: custodian, author, target Gender, birth date, contact information In specific contexts, birth order, date of death, age accuracy, birth country, mother name, indigenous status, etc. Entitlement (Medicare) Vaccine ingredients, dose number, Vaccine cancellations and their reason. The batch number and administration route and site are not recorded
Rendering for citizens	Childrens version (MC73) (Figure 25).
Sources	https://www.healthterminologies.gov.au/docs/DH_2407_2016_AMT_FactSheet_v2.1.pdf https://www.servicesaustralia.gov.au/organisations/health-professionals/services/medicare/australian-immunisation-register-health-professionals/resources/air-vaccine-code-formats https://www.servicesaustralia.gov.au/individuals/services/medicare/australian-immunisation-register

Table 62. Australia



Australian Government
Medicare Australia

Australian childhood immunisation register

Immunisation history statement - online version

As at:

For:

Date of birth: 14 September 2010

Immunisation status: up to date

Schedule	Immunisation	Date given	Brand name given	Provider type
2 months	Diphtheria Tetanus Pertussis Hepatitis B Polio Hib Pneumococcal Rotavirus	02 Nov 2010	Infanrix Hexa Prevenar 7 Rotarix	General Practice
4 months	Diphtheria Tetanus Pertussis Hepatitis B Polio Hib Pneumococcal Rotavirus	18 Jan 2011	Infanrix Hexa Prevenar 7 Rotarix	General Practice
6 months	Diphtheria Tetanus Pertussis Hepatitis B Polio Hib Pneumococcal	29 Mar 2011	Infanrix Hexa Prevenar 7	General Practice
12 months	Hib Measles Mumps Rubella Meningococcal C	26 Sep 2011	Hiberix Priorix Meningitec	GP
18 months	Pneumococcal Varicella	20 Mar 2012	Prevenar 13 Varilrix	GP
4 years	Diphtheria Tetanus Pertussis Polio Measles Mumps Rubella	11 Nov 2014	Infanrix-IPV Priorix	GP

Next immunisation(s) due	Date due

This child has received all vaccines required by 5 years of age.

Every effort is made to ensure that the information contained on the Australian Childhood Immunisation Register is correct. The data is based on information provided to Medicare Australia by immunisation providers and the accuracy of data is dependent on the quality and timeliness of information provided. Immunisation records are only available from 1 January 1996.

Figure 25. Rendering in Australia

1.4.32. Iceland

Summary	A centralimmunisation registry exists since 2007 within the national EHR infrastructure. It is accessible for citizens at https://www.heilsuvera.is. No technical detail was found online.
Syntax	-
Citizen identity	-
Vaccine designation	The referenced presentation mentions ATC or HL7 (sic) for codes of vaccines. The screen capture shows brand names.
Additional information	Date and place of vaccination; Refusal of vaccination
Other terminologies used	-
Rendering for citizens	Figure 26.
Sources	https://www.heilsuvera.is/ https://www.landlaeknir.is/servlet/file/store1/item25603/version1/Bolusetningar.png https://www.landlaeknir.is/um-embaettid/greinar/grein/item20338/Spurningar-og-svor-um-rafraena-sjukraskra

Table 63. Iceland

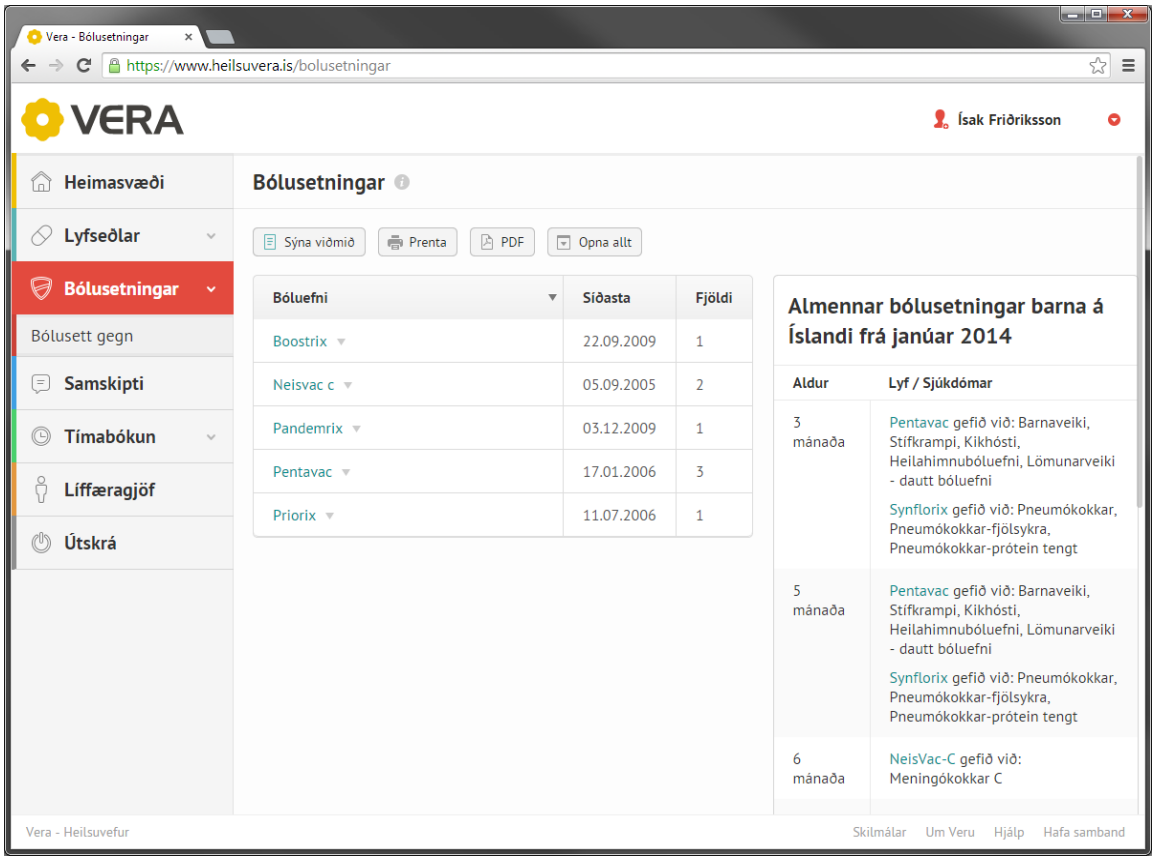


Figure 26. Rendering in Iceland

1.4.33. Liechtenstein

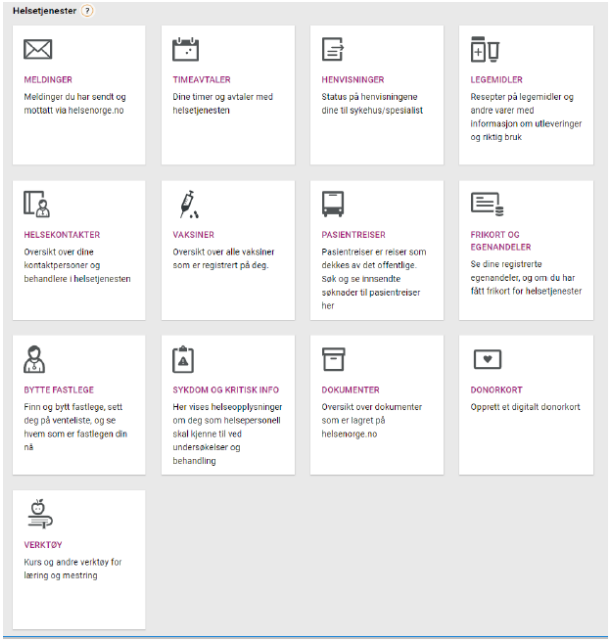
No evidence was found regarding the existence of an IIS.

1.4.34. Norway

Summary	SYSVAK is the centralized IIS used by all professionals in Norway. It is synchronized with Electronic Patient Records of public health centres, General Practitioners, and travel vaccination centres. The citizen can access it through the national, multipurpose portal helsenorge.no and can print paper copies on their own or get certified (stamped and signed) copies from public health centres. Access is implicitly granted to every health professional. SYSVAK was initiated in 1995. It now contains 3.5M cards, for a total of 40M recorded vaccinations.
Syntax	The transactions between the EPRs and SYSVAK use the ebXML format.
Citizen identity	Every resident in Norway has a 13-digit personal identification number. It is complemented with gender, name, surname, address.
Vaccine designation	SYSVAK uses a combination of a proprietary SYSVAK vaccine (antigens) code and drug code, plus the brand name. The ATC code is also referenced. The list of vaccine codes is available at the referenced site. Drug codes are prefixed by the vaccine code, followed by a sequential number.
Additional information	Non-executed vaccinations and their justification are also recorded as events. Batch number, origin of information (paper card, oral, done locally) are recorded for each vaccination.
Other terminologies used	-
Rendering for citizens	See Figure 27.
Sources	• Interview with Hilde BAKKE and Marianne BERGSAKER on May 8th • Citizen portal at http://helsenorge.no/Sider/default.aspx • Vaccine codes at https://www.fhi.no/hn/helseregistre-og-registre/sysvak/sysvak-koder/ • Technical documentation and XML schemas at https://sarepta.ehelse.no/standard/SYSVAK

Table 64. Norway

Helsenorge portal after authentication:



Vaccines page:

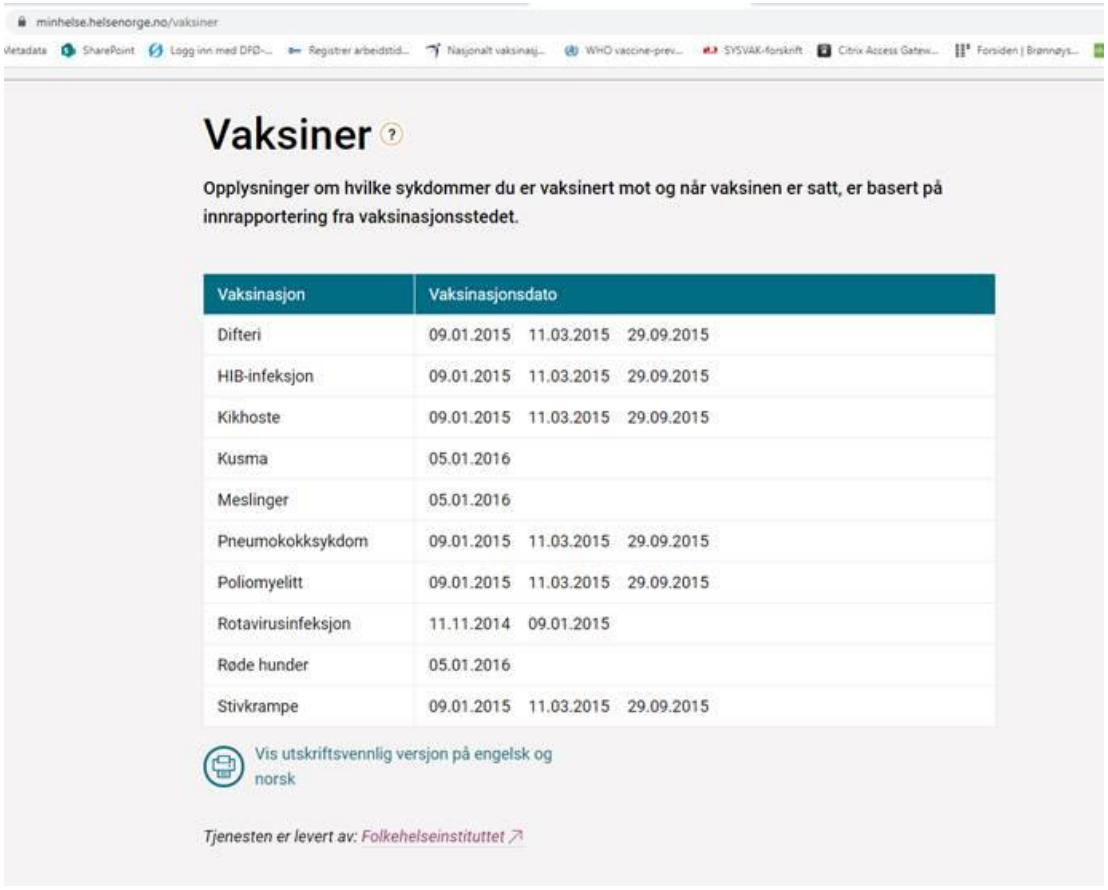


Figure 27. Rendering in Norway

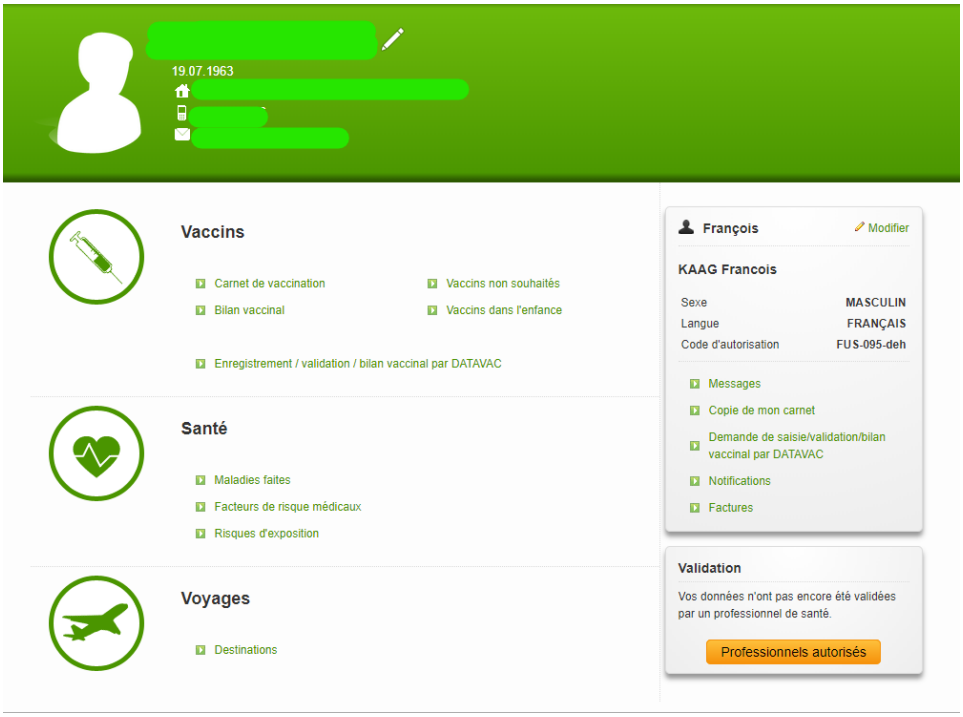
1.4.35. Switzerland

Nota : the collection was operated during spring 2020. The service was discontinued in August 2021.

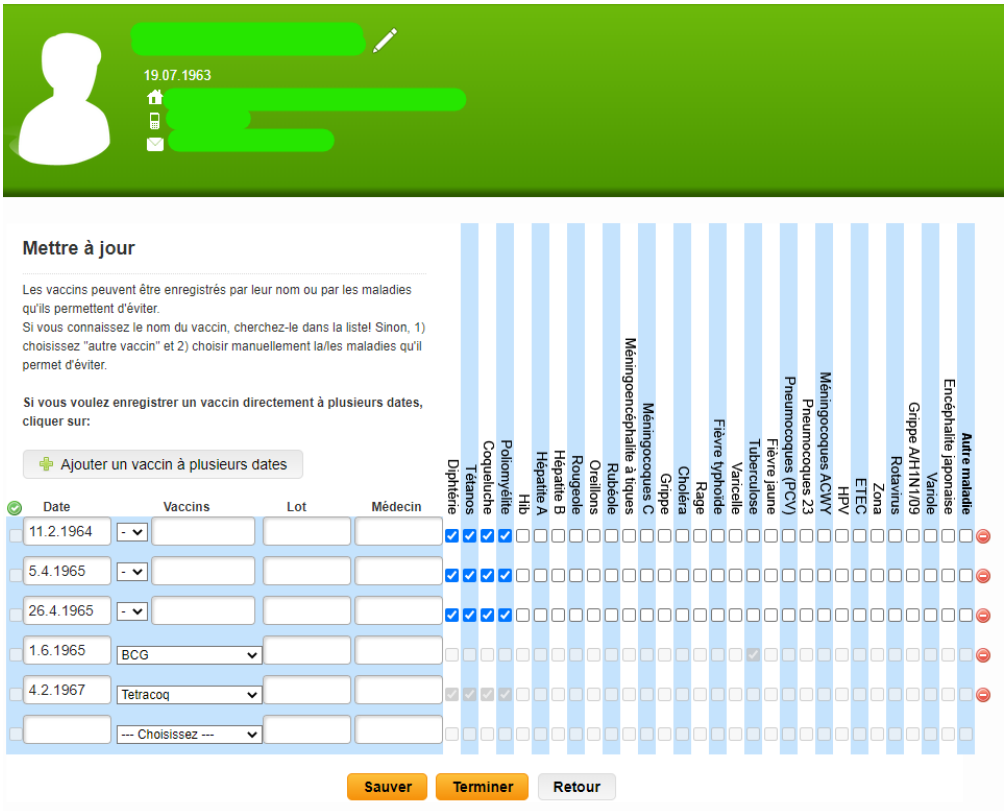
Summary	With MesVaccins.ch, Switzerland has one of the most comprehensive dVCs so far, providing personalized recommendations according to the citizen profile. It is accessible at www.mesvaccins.ch or through the myViaVac mobile application.
Syntax	The exchange format is a CDA document under the Immunization Content profile.
Citizen identity	The patient is documented into the recordTarget section of the CDA document with its identity traits.
Vaccine designation	The vaccine substance is represented by an ATC Code, complemented with the product trade name, package barcode (GTIN), batch number and manufacturer name.
Additional information	The CDA document presents all the usual sections of the Immunisation Content profile, such as Past Illnesses, Allergies and Intolerances, Pregnancy observation, Laboratory results, etc. Immunisation recommendations and Adverse events may be present.
Other terminologies used	
Rendering for citizens	Figure 28.
Sources	https://www.mesvaccins.ch/ https://www.e-health-suisse.ch/fileadmin/user_upload/Dokumente/2018/D/180507_CDA-CH-VACD_de.pdf https://gitlab.com/ehealth-connector/api/-/wikis/CDA-CH-VACD

Table 65. Switzerland

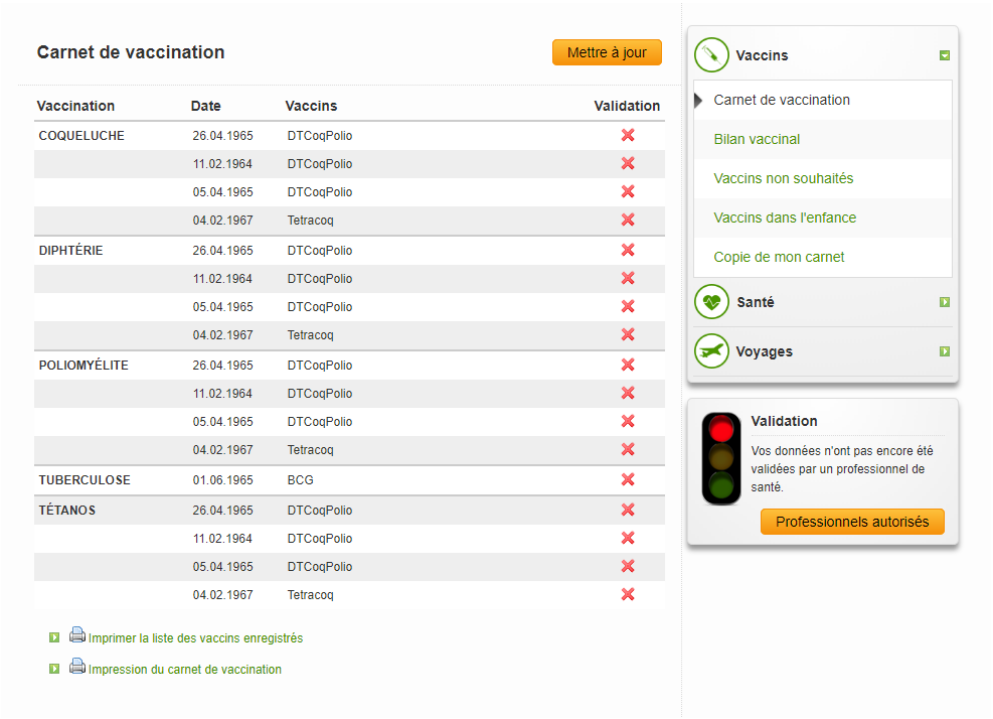
Home page:



Entering a vaccine by brand or by antigens:



Display of vaccination history by target disease.



Immunisation status (colour code)

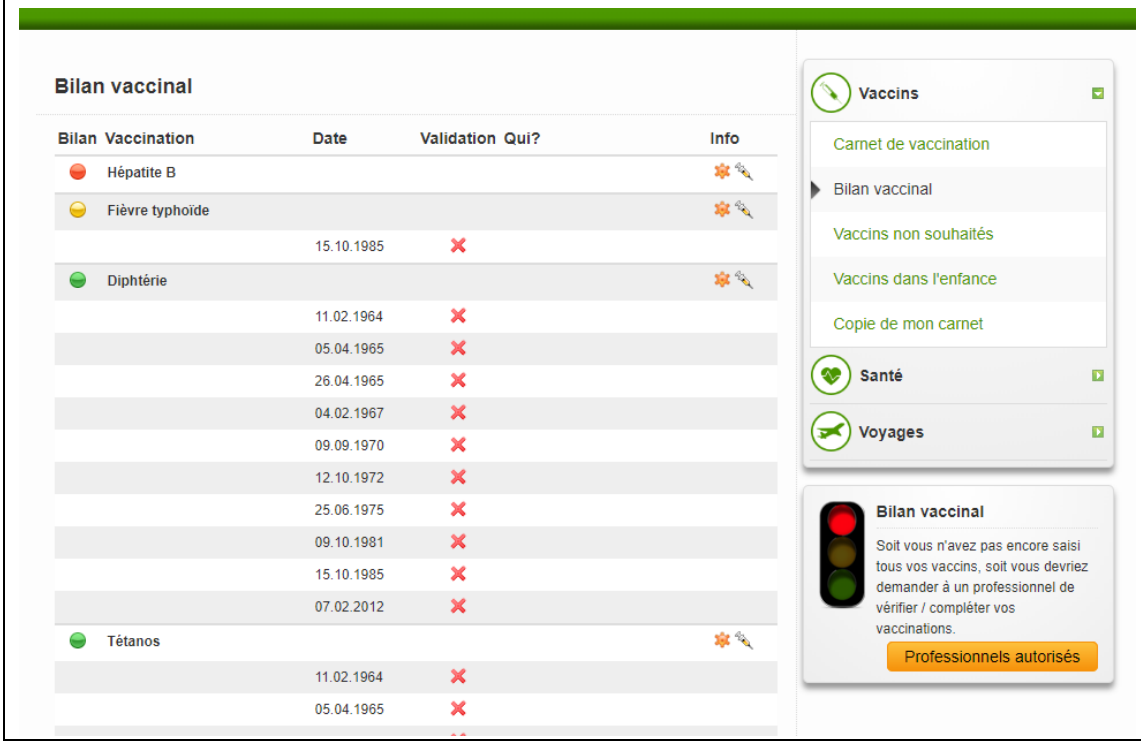


Figure 28. Rendering in Switzerland