



Interoperability in Digital Health

Reference material



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Interoperability in Digital Health

Reference material



Content

Executive summary	5
Introduction	7
How is interoperability classified?	8
Syntactic interoperability	9
Messaging standards	9
Document Standards	10
Combined messaging and document standards	12
Semantic interoperability	13
What is the hardest part?	15
Do we need to be interoperable? benefits and barriers	19
Benefits	19
Barriers	22
What conditions should be encouraged to achieve interoperability in Health?	26
Which International Organizations develop health standards?	29
International Organization for Standardization	29
Health Level Seven	30
World Health Organization	31
SNOMED International	31
Regenstrief Institute	33
Integrating the Healthcare Enterprise	34
Standardized EHR Models (openEHR)	35
Are there projects in the region?	37
Any experiences outside the region?	40
European Patients Smart Open Services	41
International Patient Summary	43
My Health Record	45
Shared Medical Record in Catalonia	46
Conclusions	48

Executive Summary

The growth of digital health strategies has increased health professionals' access to their patients' health information, but one of the key problems in health informatics remains the lack of interoperability between different information systems. Better access to information, including health records from other institutions, is still needed to improve the quality of care and establish continuous patient care. To improve the quality and safety of patient care, doctors need this improved access with minimal disruption to their workflow, and that requires accelerating interoperability efforts.

The following five key points are central to achieving interoperability:

- 1. Establish an interoperability framework.** An interoperability framework contains the set of policies, guidelines, standards, rules, and recommendations devised by a network of actors to achieve the highest possible level of interoperability.
- 2. Promote the development of information systems and their integration.** This involves adopting open-ended solutions and providing tools or services that facilitate implementation.
- 3. Empower the patient.** Put the patients in charge of their own information with tools that give them the power to decide how their data is used. Then, respect their rights and wishes while keeping the information safe and secure.
- 4. Resolve legal and regulatory concerns.** Implementing an interoperability scheme involves adjusting to or establishing medical history laws. The implementation must resolve issues such as information access rules, authorship (including date and time of record creation), digital signatures, information integrity, security policies, and data modification processes. Because legal and regulatory issues are location-specific, an implementation must be adapted to the environment.
- 5. Human capital development.** All health system users should be trained on the validity of the new scheme as well as on topics such as its challenges and changes. Medical professionals, patients, and administrative staff should all be trained. The goal of training is to lower barriers and allay fears to gain buy-in for the adoption and give access to the leaders and techni-

cians who will implement the system.

The objective of this document is to introduce the main tools and strategies to achieve an integrated system that allows other systems with different architecture, data models, and platforms to share their information.

Introduction

Health care provision is increasingly a shared responsibility among a group of professionals from a range of disciplines and institutions. Accordingly, one of the main challenges for the health sector is solving how to easily and securely share patients' health information, particularly their medical histories, while preserving the original meaning of the data.

As hospitals and care centers grow, and their information processing operations expand with them, the need to share patient data becomes critical.

There is no single definition of the term interoperability, much less interoperability in the field of health because its meanings depend on the context. It can be defined as “the ability of different information systems, devices and applications ('systems') to access, exchange, integrate and cooperatively use data in a coordinated manner, within and across organizational, regional and national boundaries, to provide timely and seamless portability of information and optimize the health of individuals and populations globally” (HIMSS, 2019).

In general, the most commonly used definition comes from the IEEE (Institute of Electrical and Electronics Engineers), which defines interoperability as “the ability or capability of two or more systems to exchange information and use the exchanged information” (IEEE, 1991). This concept encompasses two distinct ideas: the first is the exchange of information (syntactic interoperability), and the second is that the information exchanged can be properly understood, processed, and effectively used by the recipient (semantic interoperability).

How Is Interoperability Classified?

Interoperability is often classified into levels, although there is no clear consensus on what the different levels are, and some even argue that it is wrong to think of levels as Walker et al. (p. w 5-11) does (see Figure 1) because interoperability either is or is not achieved. For interoperability to be effective, technical, semantic, syntactic, and organizational interoperability must be met. Without one of them, there is hardly interoperability.

The figure below shows some frequently used classifications.

Figure 1. Different types of interoperability classification

Classifier	Interoperability levels
Walker et al.	<p>Level 1: Nonelectronic data; no information systems are used for data exchange.</p> <p>Level 2: Electronic transmission of nonstandardized information; information cannot be electronically manipulated.</p> <p>Level 3: Electronic transmission of structured and machine-organizable nonstandardized data; requires interfaces to translate the data.</p> <p>Level 4: Electronic transmission of coded and standardized data; information encoded and interpretable by the receiver and sender.</p>
Healthcare Information and Management Systems Society (HIMSS)	<p>Foundational (Level 1) – establishes the inter-connectivity requirements needed for one system or application to securely communicate data to and receive data from another</p> <p>Structural (Level 2) – defines the format, syntax, and organization of data exchange including at the data field level for interpretation</p> <p>Semantic (Level 3) – provides for common underlying models and codification of the data including the use of data elements with standardized definitions from publicly available value sets and coding vocabularies, providing shared understanding and meaning to the user</p> <p>“New” Organizational (Level 4) – includes governance, policy, social, legal and organizational considerations to facilitate the secure, seamless and timely communication and use of data both within and between organizations, entities and individuals. These components enable shared consent, trust and integrated end-user processes and workflows</p>

Classifier	Interoperability levels
Health Level Seven (HL7)	<p>Technical: Exchange of data and not of meaning; generally related to hardware or software components, with systems and platforms that allow system-to-system communication; often focuses on communication protocols and the infrastructure needed for data exchange.</p> <p>Syntactic: Related to how information is structured at the time of exchange; transmitted messages, documents, and services need to have a well-defined syntax and coding so they can be interpreted by the software that receives them.</p> <p><u>There are also two main currents:</u></p> <p>Semantic: Receiver interprets the meaning in the same way as the sender.</p> <p>Process: Optimal integration of the data exchanged and work processes.</p>

The HL7 classifications are explored further below.

>> Syntactic Interoperability

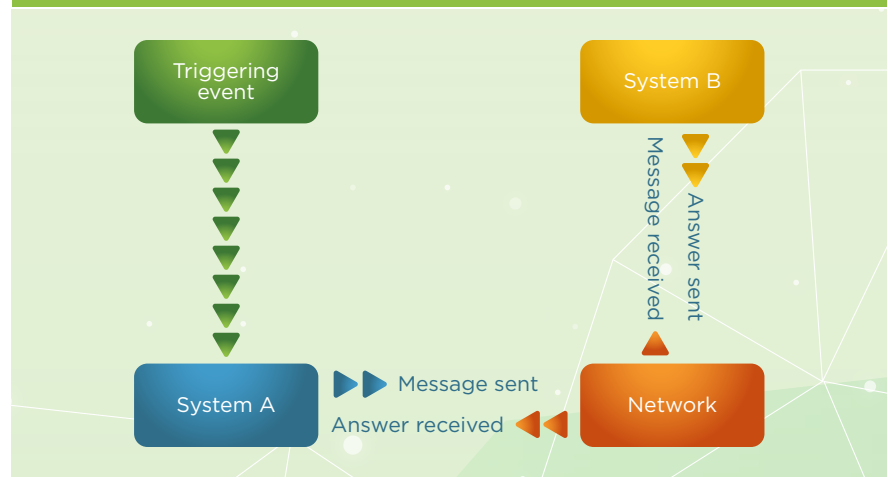
This type of interoperability involves two components. One is the exchange of messages, which are processed but do not require persistence, and the other is the exchange of documents. The following subsections examine each element in detail.

>> Messaging Standards

These standards are specifications that allow for a consistent exchange of information between systems and organizations and contain instructions for structuring the data to be exchanged. Common standards include HL7, for patients' administrative data, such as demographic information or information on consultations with medical providers; Digital Imaging and Communications in Medicine (DICOM), for radiological images; and National Council for Prescription Drug Programs, for electronic prescriptions.

The exchange model is simple: the data exchange occurs between two systems as the result of a triggering event, such as a patient admission.

Figure 2. Example of patient information exchange workflow



The messaging standard also specifies how the information is to be structured at the time of the exchange, although the related technical details will not be explained here. As such, it does not matter how each system has stored the information in its data model or what the system is. After the exchange, the information must be structured according to the applied messaging standard. This allows the system that generates the information to use a single format and, when receiving messages from other systems, know exactly how to access the information.

For example, in HL7 version 2.8, to specify the patient's name, the information has to be structured as shown in Figure 3.

Figure 3. Example of the structure of an HL7 message

- **Patient name (XPN) 00108**
- **Components:** <family name (ST)> ^ <given name (ST)> ^ <middle initial or name (ST)> ^ <suffix (e.g., JR or III) (ST)> ^ <prefix (e.g., DR) (ST)> ^ <degree (e.g., MD) (ST)> ^ <name type code (ID) >

>> Document standards

These standards dictate the kind of information to be included in a document and where it can be found. Medical records commonly use Continuity of Care Record (CCR), which provides a standard format for communication between healthcare professionals that includes a patient's identifying information, clinical history, list of medications, allergies, and care plan recommendations. Another widely used document standard is clinical document architecture (CDA).

Figure 4 shows a fragment of CDA document code, and Figure 5 shows a CDA document in a browser.

Figure 4. Example of CDA code

```

1 <?xml version="1.0" encoding="ISO-8859-1" standalone="yes"?>
2 <?xml-stylesheet type="text/xsl" href="CDA-xsl/CDA.xsl"?>
3 <ClinicalDocument xmlns:xsi="http://www.w3.org/2001/XMLSchema instance"
4   xsi:schemaLocation="urn:hl7-org:v3 ../.././AyudaMedica/CDA.xsd"
5   xmlns="urn:hl7-org:v3"
6   xmlns:cda="urn:hl7-org:v3"
7   xmlns:sdct="urn:hl7-org:sdct">
8   <!-- ** CDA Header ** -->
9   <realmCode code="AR"/>
10  <typeId root="2.16.840.1.113883.1.3" extension="POCD_HD000040"/>
11  <!-- Plantilla General MAIS, y la fecha de la versión -->
12  <templateId root="2.16.840.1.113883.2.10.24.1.1.99" extension="2015-03-01"/>
13  <!-- Nota: El proximo templateID, codigo y titulo dependen del tipo especifico de documento
14  01-Epicrisis** -->
15  <templateId root="2.16.840.1.113883.2.10.24.1.1.1" extension="2015-03-01"/>
16  <!-- Identificador único del documento - MAIS_Ref:#D02-->
17  <id extension="1029988-1" root="2.16.840.1.113883.2.10.24.2.1.9999.1"/>
18  <!-- Clasificación del Documento - MAIS_Ref:#D01 -->
19  <code codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC" code="18842-5"
20    displayName="Epicrisis"/>
21  <!-- Titulo -->
22  <title>Hospital Ejemplo: Epicrisis</title>
23  <!-- fecha de Creación del documento - MAIS_Ref:#D03 -->
24  <effectiveTime value="201503171904+0300"/>
25  <!-- Código de Confidencialidad - MAIS_Ref:#D04-->
26  <confidentialityCode code="N" codeSystem="2.16.840.1.113883.5.25"/>
27  <!-- Código de Lenguaje: español de Argentina -->
28  <languageCode code="es-AR"/>
29  <!-- Identificador de Documento Original -->
30  <setId extension="1029988" root="2.16.840.1.113883.2.10.24.2.1.9999.2"/>
31  <!-- Versión del Documento -->
32  <versionNumber value="1"/>
33  <!-- Datos del Paciente -->
34  <recordTarget>
35    <patientRole>
36      <!-- Identificador del Paciente #1: Tipo y Número de Documento - MAIS_Ref:#P07 - MAIS_Ref:#P08-->
37      <id extension="200000000" root="2.16.840.1.113883.2.10.24.4.1"/>
38      <!-- Identificador del Paciente #2: Número de Historia Clínica Prestador -->

```

Figure 5. Example of CDA viewed through a browser

Hospital Ejemplo: Epicrisis

C:/Users/UsuarioHI/Dropbox/MAIS_COMPLETO/DOC_ADJUNTOS_FACTURACION...

Hospital Ejemplo: Epicrisis

Paciente	: FUNES GONZALEZ Alberto José Fecha de Nacimiento: Mayo 1, 2005 (9años) Género: Masculino ID paciente: 200000000 (2.16.840.1.113883.2.10.24.4.1) , 29282 (2.16.840.1.113883.2.10.24.2.1.9999.3)
Autor:	SANDOZ BALBUENA Joaquin Manuel , Generado el: Marzo 17, 2015, 19:04 +0300

Tabla de Contenidos ▾

1 MOTIVO DE INGRESO
Dolor persistente en lado izquierdo del pecho

2 DIAGNOSTICO DE INGRESO
Infarto agudo de miocardio

3 ANTECEDENTES FAMILIARES
Padre fallecido a los 57 años (Infarto de miocardio)
Madre y tíos diabéticos

4 ANTECEDENTES PERSONALES
Operado de apéndice en 2010

5 HISTORIA DE LA ENFERMEDAD ACTUAL
El paciente reporta limitaciones para respirar luego de caminar unas cuadras
Laboratorio dos días antes del ingreso: Glucose 110, creatinina 1.1, electrolitos normales. Hematocrit 29%. Bcos 7300, plaquetas 256,000. Urocultivo y analisis de orina normales

6 EXAMEN FISICO
Niega fiebre

7 CURSO CLINICO
Paciente que se presenta con dolor precordial. Luego de examen físico, imágenes y laboratorio, se deriva a

>> Combined messaging and document standards

HL7's Fast Healthcare Interoperability Resources (FHIR) standard covers messaging and document standards, as well as issues such as services and bulk-data, sending. This standard was easy to develop, simple to learn and it has minimal tool-specific requirements. In addition, it is easy to implement (or as easy as interoperability can be in health) and semantically robust, and it has the advantage of using common tools, formats, and current web-based technologies (HTTP, XML, JSON, and others). Another advantage is that it uses an information exchange based on a representational state transfer (REST) application programming interface (API).

An API is a set of rules and specifications that applications follow to communicate with each other. It is the most useful mechanism for connecting two pieces of software, ensuring that messages and data are exchanged in a standard format, and it can be easily integrated into mobile and web applications. An API allows data to be exchanged with any health information system using the modular components that FHIR refers to as “resources.”

A fragment of a patient resource appears in Figure 6.

Figure 6. Example of a message in FHIR

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <Patient xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
3   xsi:schemaLocation="http://hl7.org/fhir ../../../../Documents/FHIR/fhir-all-xsd-R4/patient.xsd"
4   xmlns="http://hl7.org/fhir">
5   <text>
6     <status></status>
7
8     <div xmlns="http://www.w3.org/1999/xhtml">
9       <table>
10        <tr>
11          <td>Fernando Campos AKA Percam, Male, born 1968-05-11</td>
12        </tr>
13      </table>
14    </div>
15  </text>
16  <identifier>
17    <use value="usual"></use>
18    <system value="www.hospitalitaliano.org.ar"></system>
19    <value value="123456"></value>
20  </identifier>
21  <name>
22    <family value="Campos"></family>
23    <given value="Fernando"></given>
24  </name>
25  <telecom>
26    <system value="phone"/>
27    <value value="(03) 5555 6473"/>
28    <use value="home"></use>
29  </telecom>
30  <gender value="male"></gender>
31  <birthDate value="1968-05-11"></birthDate>
32
33
```

FHIR provides more stability than previous standards and ensures that future versions remain compatible with existing standards. Future changes must be backward compatible, so applications that implement the regulatory parts of R4 (Release 4 or version 4) do not run the risk of not being compliant with the standard. Note that FHIR is not HL7's "version 4," although it is based on several previous HL7 data standards.

>> Semantic Interoperability

This type of interoperability is about making sure that systems and the information they exchange have the same vocabulary, without which the meaning of the information is lost. There may be reference vocabularies in use at the global, national, regional, or local level, so the systems involved need to operate with any relevant terms. Two key principals in semantic interoperability are *terminology standards* and *organizational interoperability*.

- **Terminology standards** are those which provide a vocabulary of specific codes for clinical concepts—such as diseases, allergies, medicines, and procedures—that may have variants in paper records or transcriptions. Some examples of terminology standards are Logical Observation Identifiers Names and Codes (LOINC), for laboratory studies; Systematized Nomenclature of Medicine (SNOMED), for clinical terms; and International Classification of Diseases (ICD) by the World Health Organization (WHO), for medical diagnoses.
- **Organizational interoperability** refers to when and under what conditions organizations communicate and transfer data, even when this exchange involves a variety of information systems with diverse infrastructures in different geographical and cultural regions.

Figure 7. Interoperability Levels



A good analogy for understanding the different levels of interoperability is the use of email, which allows you to send and receive messages and attachments. To get the message to the destination, the sender and the recipient must use valid addresses and an email protocol such as SMTP or POP3, an email client, or something similar. In creating and transmitting information among recipients, technical interoperability is achieved. Yet, the delivery protocol does not specify the content of the shipment or language.

To achieve syntactic interoperability, it is important to be familiar with and have the software to open the file. The email may contain an attachment in a format that cannot be opened by the recipient. For example, if you receive a file of type “attachment.virus,” what program would allow you access to a .virus file? And would you open it?

Semantic interoperability further requires language compatibility. Because content can be written in different languages, such as Japanese or Arabic, that have different spellings, both the sender and the receiver must share a common vocabulary to interpret the message or attachment content.

Organizational interoperability comes into play when actions are generated by the content exchanged. For example, a message could say something like “upon receipt of this authorized email, proceed with sending the prosthesis to the establishment.” This email indicates that something must be done, and its execution can be associated with organizational interoperability (Hovenga et al., 2010).

Taken together, the four levels of interoperability ensure that the information is correctly exchanged, interpreted, and used between different systems, suppliers, and technologies. The best combinations of standards to achieve this mix of information ex-

change standards are set down in highly detailed implementation guides or technical profiles, such as Integrating the Healthcare Enterprise (IHE).

>> What is the hardest part?

Of the different levels of interoperability, **semantic** is the most difficult one to address because the correct application of descriptors to medical knowledge is not an easy task.

For example, when implementing an electronic clinical history (ECH), system users will need to be able to add information to patient charts, such as findings, treatment processes, and outcomes of health care using natural speech patterns without restrictions (Rector, 1999). Plus, patient data comes from different sources, which complicates the issue. A record may include patient symptoms, the progression of the patient's condition, a procedures list, a medicine list, laboratory test results, results of complementary studies, social determinants of environmental health information, clinical decisions and treatments, genomics and proteomics, and similar issues.

The richness of language, including in the medical setting, is difficult to capture. Natural language includes an expansive vocabulary that is rich in detail but also ambiguous. The context of information is extremely informative, and jargon, acronyms, and abbreviations often lack precise definitions. As a result, it is necessary to design strategies to eliminate ambiguity and standardize language to ensure that clinical information stored in health information systems can be used for statistical purposes, managerial decision-making, or decision-support tools for improving the quality of patient care.

A controlled vocabulary is a pre-approved list of words for use in a given situation. When applied in a user interface, it is a list of terms that the user can choose to represent a fact or a reality situation (Lopez Osornio et al., 2005). Some of the main characteristics of controlled vocabularies, contrary to those of natural language, are rigidity, unambiguity, precision, and standardization. New concepts have to be integrated into the vocabulary, and people are trained on their use. These characteristics make controlled vocabulary a key component in achieving semantic interoperability by ensuring that what the user records will translate across different healthcare domains.

The ideal would be to control how patient documentation is composed and ensure structured development of patient record contents, including clinical observations and evaluations, testing

and results, medication lists, nonpharmacological results, and nonpharmacological treatments (see Figure 8). However, doing so would be difficult.

Figure 8. Free text Vs. controlled vocabularies

The image illustrates the contrast between free-text handwritten medical notes and a structured digital medical record. The top half shows a handwritten prescription form with fields for patient name, date, and medication. The bottom half shows a digital interface with a patient record and a list of events (Evoluciones). The digital record includes a detailed description of a blood transfusion procedure, including the date, time, and location, as well as the patient's condition and the procedure's outcome.

Ámbito	Sector	Servicio Médico
Internacion General	SECTOR INTERNACION 110 - GERIATRICO	CLINICA MEDICA

Ingreso	Hoy	Equipo tratante
fecha hora Probable Egreso 18/09 16:07 08/06/2019	días cama 321 11001	coordinador tratante Schutz Jauregui

Motivo	intensivos	general
prueba (admisión: programado)	4	317

Evoluciones 1 / 207

- 06/08/19 11:20 - CASSARINO MELANIE BARBARA
AREA DE INFORMATICA CLINICA
- 06/08/19 11:19 - CASSARINO MELANIE BARBARA
AREA DE INFORMATICA CLINICA
- 05/08/19 11:53 - RAMIREZ MARIA FLORENCIA
SALUD MENTAL PEDIATRICA
- 01/08/19 13:43 - JAUREGUI OSCAR IGNACIO

Se realizó TRANSFUSION DE PLAQUETAS 5 unidad(es), dentro de las 4 hs de solicitadas. El motivo de la Transfusión es ALERGIA A AGENTE ANTIBIOTICO BETA LACTAMICO. Solicitada por SANTORO DIEGO a las 06/08/2019 11:20:15. Datos de Laboratorio: Hemoglobina 0.0, Hematocrito 0.0, Plaquetas 0.

Previo a la transfusión se verificó la identidad de: PRUEBA MUJER y que posee consentimiento informado para el actual episodio. Se educa al paciente y/o responsable a cargo sobre los riesgos y beneficios de la misma.

Hora de inicio de la Transfusión: 06/08/2019 00:00:00
Ventana de viabilidad para la transfusión: 06/08/2019 01:00:00

Furthermore, over time, the names of diseases and surgical procedures evolve and multiply, and the use of more than one term for the same disease complicates information collection and retrieval. The health industry works to organize and standardize medical language, developing nomenclatures, classification systems, and clinical vocabulary.

Systems must speak a common language and use a common code to speak to one another. Writing in this language is called coding. Coding is the assignment of numeric and alphanumeric codes to diagnostics, procedures, and services, and it is usually done by people who work as coding specialists.

The challenge of coding in health is to encode messages in such a

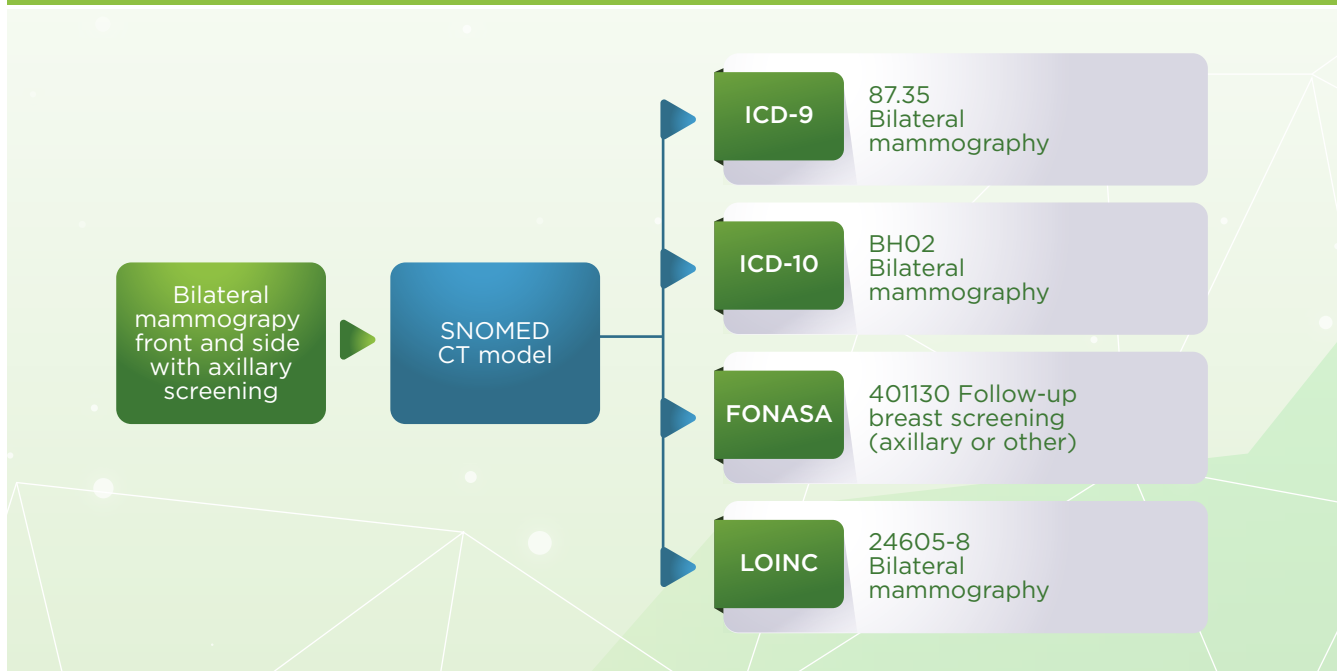
way that the original can be interpreted by another health professional with perfect accuracy. This is why it is important to find a way to encode context as well as words.

When deciding on a controlled vocabulary for implementation, a range of alternatives needs to be considered. The most appropriate one should be chosen for the scenario based on the objectives, available resources, training costs, legal considerations, billing requirements, and similar concerns.

To illustrate how models would differ, an example of how three systems would record an order for bilateral mammography follows.

- **A model with traditional coding** (manually coded after the consultation, possibly several months later) **and natural language and vocabulary**. In such a situation, each implementation would require end-user training on the terms and categories to define the patient's situation. Coding could vary according to the locally preferred nomenclature. For example, Argentina has a national nomenclature, and Chile uses FONASA (Fondo Nacional de Salud) codes. In Chile, the code for a bilateral mammogram is FONASA 401130.
- **A model with traditional coding and standardized classifications**. This is the most commonly used model. It uses standardized classifications (for example, ICD-10). There are few technology requirements and many implementation alternatives based on who is chosen to do the coding and whether IT help will be provided. In such a model, a bilateral mammogram could be coded with ICD-9 code 87.35, ICD-10 code BH02, or LOINC code 24605-8.
- **A model with terminology services**. These models use a fixed nomenclature, such as SNOMED CT, and the classifications are used as the vocabulary in reports and analysis. Some of the most commonly used classification systems are ICD-9-CM, ICD-10, the International Classification of Primary Care, and LOINC. This model requires higher technological requirements, and it is essential to have computerized records. Users must select a term to use the system (termining). A bilateral mammogram in a system using SNOMED CT is coded as 43204002.

Figure 9. Example of terminology services



The range of models in use includes manual coding using non-standard codes to manual coding with standardized codes to the most IT-intensive and the best option for interoperability, which is automated language in automated processes that standardize knowledge representation and reduce interpretation errors.

Another challenge, albeit a less complicated one, is to uniformly capture a representation of the entities involved in medical practices, such as the people, organizations, specialties, services, medicines, and so forth. In general, these situations are resolved with common master tables and dictionaries that can be accessed through services.

Do we need to be interoperable?

Benefits and barriers

>> Benefits

For projects aimed at continually improving healthcare, interoperability is an important concept. For example, the *Quadruple Aim framework* focuses on improving health care and optimizing the health of individuals and the population in four dimensions:

1. Improve the patient care experience (including quality and satisfaction), for a *better patient experience*
2. Improve the health of the population served, for *better population health*
3. Reduce the per capita cost of health care, for a *lower cost of care*
4. Improve the working lives of healthcare providers, including doctors and staff, for *better provider well-being*

This initiative is based on the fundamental belief that solutions to national problems, such as healthcare, can be found and designed at the local level. For the patient, this means a better culture of care, better care, better health, and lower costs.

The need for and benefits of interoperable systems, as well as their role in achieving the aims, are not always discussed. But there are benefits of interoperability for each aim.

From a patient's point of view, interoperability increases patient safety by increasing access to and the availability of clinical data. Real-time access to data helps physicians pick up a patient's care at any point in a treatment, which improves the quality and continuity of care. Patients also have the benefit of accessing patient portals to see their records, which they can share with others. In addition, patients can use different services within the health system and have instant access to their records, which facilitates requests for a second opinion, more agile health service provision, and even movement between public and private care systems (e.g., patients with two types of health insurance) or healthcare providers.

At the government level, public health initiatives are based on

data reported by healthcare providers, and health service funding often has to be administered through multiple systems, so the potential for errors and incomplete data increases (Hammond et al., 2010).

Tracking the use of the necessary resources and managing information on how, when, and where those resources are used informs interoperability concerns. Several largescale reporting systems rely on this, such as mandatory disease reporting, seasonal pathology monitoring, antibiotic resistance and community morbidity information, disease and pathology incidence, public health research, and disaster response.

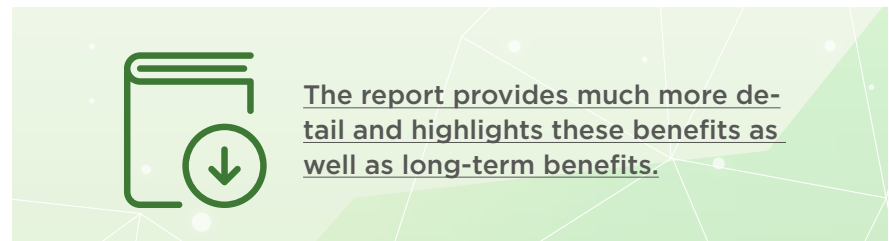
In an integrated system, with shared and shareable information, data would be available for consultations, referrals, medical equipment availability, and similar issues. For example, in a 2017 study of Canada's interlinked health system, the following benefits were revealed:

- The health system saved C\$72.7 million in outpatient settings through a reduction in lab test duplications and \$6.7 million on reduced diagnostic imaging duplications. As a result, patients spent 1.86 million hours less in care settings, which increased annual economic productivity by C\$49.5 million.
- Interconnected health information in emergency settings saved the system C\$9.0 million through reduced lab test duplications and \$19.5 million through reduced imaging duplications.
- Interconnected information reduced hospital admissions for patients in the emergency department, saving C\$334.95 million, 8.5 million hours of hospitalization for patients, and 33,000 provider hours. Real-time information access helps providers know when a patient is experiencing something that does not require hospitalization.
- Hospital readmission also drops because doctors can track post-hospital follow-up more effectively and make proactive decisions to prevent readmission. These reductions generated savings of \$198.29 million, 19,000 provider hours, and 5.1 million patient hours—contributing \$40.7 million in economic productivity each year.

At the organizational level, the benefit comes from achieving interoperability between legacy and new business systems that have different programming languages, communication protocols, and data models or interfaces, as they need to share and use the same information in multiple places. This integration means that information does not need to be entered twice, which decreases the probability of data upload errors. (Glaser, 2011). One study showed that the prevalence of the errors from such duplication

can range from 2.3 percent to 26.9 percent, with errors in data entry, interpretation of information, transcription typos, or omission of dictated information from the transcription (Goldberg et al, 2008).

At the point of care, information on consultations, doctors' comments, and medications prescribed or taken by the patient is available to all members of the care network. The availability of complete and accurate data enables continuous assistance and allows the user of clinical information systems to make diagnostic and treatment decisions with more and better information that contributes to better care provision (Halamka et al., 2005).



Finally, **from an economic point of view**, interoperability improves the management of health services and reduces costs by reducing redundancies because providers share patients' information. These benefits also apply to orders for medications, imaging studies, surgeries, hospital stays, and emergency room visits, greatly reducing expenses in numerous areas (Sridhar et al., 2012; Frisse and Holmes, 2007; Ben-Assuli, Shabtai and Leshno, 2013).

Ben-Assuli, Shabtai, and Leshno (2013) examined the actual effect of information used from the system (from internal and external sources) at the time a doctor decides to admit a patient for hospitalization. The objective was to assess how this increased information affected the decision-making process. The authors studied the likelihood of readmission within a short period of time from a previous discharge and in single day admissions, comparing the difference between when doctors did and did not use the external information from the medical history. The authors then compared the reduction in readmissions over the next seven days and single-day admissions when local information was viewed compared to when external medical information was retrieved.

The study found that external data accessed via interoperability decreased readmissions at the hospital more than the use of only internal data by 27.2 percent for readmission within seven days and 13 percent for single-day admissions.

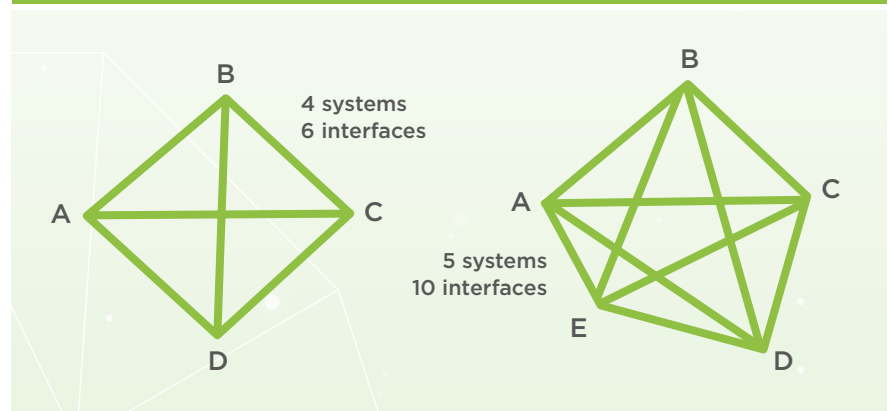
>> Barriers

Unfortunately, there are still a number of barriers that make achieving interoperability difficult. When a health institution mandates an interoperability requirement, there is often a question about the use of standards.

Sometimes there is no awareness within the hospital whether **relevant standards** exist. For example, a team may not know whether there is a standard for linking a system for pathological anatomy with the administrative system. At other times, the scope of the problem is not understood, so the problem is solved by using a one-off interface between the two institutions. On top of these complications is the competition and overlap between different standards that serve the same purpose, which is further detrimental to interoperability (Hammond et al., 2010).

The number of interfaces increases at approximately one-half of the square of the number of systems to be joined. So, under the following formula $(n \times (n-1)) / 2$, we could argue that for two systems to communicate, we need one interface, or three interfaces for three systems. But as the number of systems grows, the number of interfaces can become unmanageable.

Figure 10a. Number of interphases as a function of number of systems



What happens when the number of systems rises to 30, 40, or 50, as in complex organizations like those in health?

Figure 10b. Number of interphases as a function of number of systems

Systems	Interphases
6	15
8	28
10	45
20	190
30	435
40	780
50	1225
100	4950

Even though the role of standards is understood, adopting them is almost always perceived as an extra effort that requires a technological investment, specialized human resources, and changes in the workflow. That is, there is a perceived effort until a similar need arises and systems personnel realize that having the first standard in place saved them time with this second issue. And when a third need arises, people regret not having used the standards earlier.

In some projects, the cost of implementing standards may seem high (because of equipment purchases, software licenses, and training) and the return on investment may not be clear since the benefits are diluted among many actors, but the costs are assumed by those who adopt them early (Walker et al., 2005).

Certain industries have developed and implemented standards for electronic data exchange. With banking, for example, interoperability allows anyone to access any ATM in the world and withdraw money with a debit or credit card, and the terminal distributes the money while the account at the home bank is debited. In health-care, though, progress toward interoperability faces a number of challenges because the information is much more complex than bank account balances and standards come from a variety of organizations. Healthcare interoperability concerns patient records that are typically the sum of interactions between healthcare professionals, patients, insurers, and government agencies. Also, much of the data is uncategorized and contains text and images.

Another documented barrier is **data security and privacy concerns**. These may arise from the patients themselves, who do not want to their personal data to be left unprotected; the medical team, which does not want to be exposed to litigation or changes to the records that may lead to errors; or the organization itself, which wants to keep the number of patients it treats from other institutions or the government. Sometimes healthcare providers do not want to share their records because having control of a patient's record may prevent the patient from changing providers.

Another factor to consider is the need for specially **trained staff** to take on the challenge of implementing the change to standards adoption and interoperability. While the tools for making standards transparent to end-users (terminology services, for example) are increasingly numerous, it may still be necessary to train specialists.

According to an analysis by Chile's National Center for Health Information Systems (CENS), the public health network needs to be concerned with more than just the medical staff gap. To digitize its public system, based on the number of health services, hospitals, and clinics that would need medical computing units, Chile would need at least an additional 3,500 health information technology professionals.

On the other hand, it is very common to consider training staff in an interoperability standard—such as HL7— as an extra expense, while training in the tools or language of software development—such as HTML, CCS3, or Angular—is not, even though both trainings solve specific needs.

Finally, in Latin America and the Caribbean, the lack of **government coordination** and planned digital agendas in terms of interoperability, as well as the lack of regional reference implementation guides, are some of the more noticeable barriers. There are very few cases where the path ahead is clear.

A couple of initiatives that seem to be moving forward are Salud.uy in Uruguay and Argentina's Ministry of Health interoperability project.

What Conditions Should Be Encouraged To Achieve Interoperability In Health?

When facing an interoperability requirement, it is important to assess whether your organization is ready to take it on. Below are some objectives and instructions to consider before deciding whether to commit and allocate resources to an interoperability effort (HIMSS, 2009).

At the **government level**, the main task is to establish an interoperability framework, which is the set of policies, guidelines, standards, rules, and recommendations made by a network of actors with a view to achieving the highest possible level of interoperability. The framework also sets out the operational rules that govern the analysis, selection, adoption, and updating of each of these elements.

To ensure the production and longevity of the interoperable systems, the standards to be adopted and their conditions for implementation must be established. Several first world countries, including France, Canada, and the United Kingdom, have chosen to establish interoperability frameworks and are experiencing good results. The standards are widely used and are always considered when new system requirements arise.

Frameworks are designed only to identify key standards, not to offer unique predefined solutions (for example, in terms of which software to choose). The goal of a framework is to propose interoperability profiles and rules for the exchange of information or the identification of patients and health institutions—not micromanage choices. The objective is to facilitate and guide organizations in assessing interoperability options while limiting the number of potential standards to ensure maximum clarity.

This requires having leaders who are committed to the project, know its benefits, and are clear about the political context in which interoperability occurs. In short, it is the will of the project's leaders to define priorities and provide resources and the means to allow the project to reach the desired level of interoperability.

At the **organizational level**, the first question to ask is whether interoperability is aligned with the organization's strategic ob-

jectives at the local, regional, and national levels or whether it can at least align them with common regional goals. If the organization does not want to share information about itself, it will be hard to start an interoperability adoption process without a legal requirement to do so. Not all institutions are ready to take on this change because it requires a review of the organization's mission, vision, and objectives and the needs of patients, providers, and staff; a study of potential public and private data solutions available; and clinical and administrative data transparency. **Hence, not all stakeholders can be included in such a project.** Local and national laws and regulations must be evaluated in the same way to prepare the organization's compliance and define how the project will be administered to all stakeholders, including patients, the entire staff of the organization, and funders, among others.

Joining such a project requires **dedicated resources**. Funds may need to be directed to infrastructure, personnel, **license purchases**, and periodic needs of key areas in the institution (pharmacy, systems, administration, physicians, and others).

In addition, the risks to and impacts on the organization should be according to the need to be met. If, for example, all medicines are to be coded with SNOMED CT, but medicines are not even coded and are described in natural language, a system for prescriptions will need to be developed along with a process for implementing it into the care system. Process and change management efforts may, therefore, need to be established before technical components of interoperability can be taken on.

People are the linchpin of the project. It is people who need to be trained and people who need to be sure of the benefits the project will bring. It is necessary to define the criteria for success, identify the potential threats in achieving the goal, and mitigate or manage weaknesses in the effort.

Another aspect **to consider is the need to raise awareness about the project and share with the organization how critical the information involved is**—when patients, health providers, and others understand what the data comprise and how they are used, everyone's concerns and desires for the data system can be added to the business plan.

It is important to evaluate the benefits of the project, as the providers often bear the costs associated with its implementation. Some of these benefits are not economic, but rather are improvements to the quality of care and patient safety.

When establishing an interoperability strategy, it is important to assess the operating environment to include other key organizations in the plan. The goal will be to understand their needs and workflow as well as the rules and policies of that environment to get the interoperability strategy right. One question these organi-

zations will have to consider is whether they will participate in the initiative from the outset. For those that do participate from the outset, the time and staff involved in the process will constitute an investment expense in the project, although in return their concerns and wishes for the project will be taken into consideration from the beginning. Organizations that do not participate from the outset do not bear this development cost, as they receive already established definitions. In general, every interoperability strategy needs to create rules and adapt to processes that will directly depend on the scope of the project itself. If the strategy's guidelines come from a government or if a similar project's strategy is copied, the organizations involved will have a clearer path through predetermined rules and roles in the interoperability project.

It is important to emphasize that in **adopting interoperability standards**, local, regional, and national standards must be included in the interoperability project so that it functions at all the necessary levels. Developing an incomplete interoperability model will prevent organizations from developing a fully integrated health information system (Kukafka and Yasnoff, 2007).

Ensuring adherence to standards from the local, regional, and national levels is important because each level is likely to exchange different information. For example, at a local level, individual patient outcomes will likely be shared; at a regional level, protocols and studies will likely be shared; and at the national level, only specific findings will be shared. However the strategy needs to be the same, to adopt interoperability standards.

Which international organizations develop health standards?

It is very difficult to achieve interoperability without the use of standards, which are created by a variety of organizations including service providers, management entities, vendors, and advisory organizations. Several of these organizations have government members that have already contributed their vision and need for interoperability to the standards. These organizations generally develop standards that allow them to solve specific problems within a broader framework. Some organizations are created for the specific purpose of creating and publishing standards, while others are formed to coordinate the efforts of various organizations or the implementation of different standards.

The development of health standards often involves technical committees within a larger organization, such as the International Organization for Standardization (ISO) and its Technical Committee 215 (TC 215) on Health Informatics (ISO/TC 215) or the European Committee for Standardization (CEN) and its Health Informatics Technical Committee 251 (CEN TC/251).

Some of the most important international standards organizations working to facilitate interoperability are discussed below.

>> International Organization for Standardization

The ISO has established international standards in numerous fields, and it is working to ensure standardization in the field of health information, promote interoperability between independent systems, enable the compatibility and consistency of information, and reduce duplication. The committee has 35 member and 23 observer countries. To date, it has published 116 standards, including ISO 12967:2009 (Health Informatics–Service Architecture) and ISO/TS 22220:2011 (Identification of Subjects of Health Care). It collaborates with other organizations, such as HL7 and CEN, on developing standards for ISO accreditation, which facilitates the standards' international adoption.

>> Health Level Seven

HL7 is a nonprofit organization dedicated to providing a framework and standards for the exchange, integration, and retrieval of electronic information associated with health. Founded in 1987, HL7 consists of more than 2,300 members, 500 of which are corporations. Volunteers develop the standards and have the ability to participate in different working groups under the review of a steering committee. Although it is necessary to obtain a license to use the standards, they were released at no cost to the international community in mid-2013 (HL7's standards licensed at no cost, n.d.). Among its products, the HL7 V2.x family is probably one of the most widely used standards for data communication between health information systems, exchanging information on income, discharges, and transfers and sending requests for laboratory and radiological studies as well as study reports, among other information. Other standards developed by HL7 include the Clinical Document Architecture (CDA), based on HL7 V3, which specifies the structure and semantics of clinical documents (such as medical processes, diagnoses, and referrals), allowing them to be read by people but processed by computers (Dolin et al., 2006). Fast Healthcare Interoperability Resources (FHIR) was also released recently. This new interoperability standard uses twenty-first-century technology to resolve the limitations in earlier HL7 standards. FHIR was easy to develop, has an easy-to-manage learning curve and minimal technology-specific requirements, and it uses the same tools as any other software in development, including web-based technologies such as HTTP, XML, and JSON. FHIR is semantically robust, based on well-structured resources, with free documentation, and has the possibility to be expanded as needed.

FHIR also includes a REST API, which uses the same basics as most current applications and integrates easily with mobile devices, web applications, and data exchange with any health information system using modular components that HL7 calls “resources.”

>> World Health Organization

This United Nations body coordinates health efforts. Among its many responsibilities, the WHO regulates eHealth standards and publishes and maintains the CDF, which is the statistical classification of terms on diseases, symptoms, social issues, and others (WHO, n.d.).

Later versions of the CDF have also included diagnostic, surgical, and therapeutic procedures as well as codes that combine diagnoses and symptoms to decrease unnecessary codes. The WHO is also working with SNOMED International, the parent body of SNOMED CT, to enable cross-mapping between the two vocabularies (NIH, n.d.).

>> Snomed International

This international nonprofit organization, established in 2007, is the owner, administrator, and developer of SNOMED CT (Systematized Nomenclature of Medicine–Clinical Terms), a controlled, multilanguage clinical terminology that is organized in hierarchies, from the general to the specific, and allows for a high level of detail in the description of concepts, with semantic relationships between terms (About SNOMED CT, n.d.).

Topics covered by SNOMED CT include signs/symptoms/disease, interventions/procedures, observable entities, anatomical structures, organisms, and pharmacological substances and products. The terminology is composed of the concepts, terms, and relationships necessary to represent medical information in the health field.

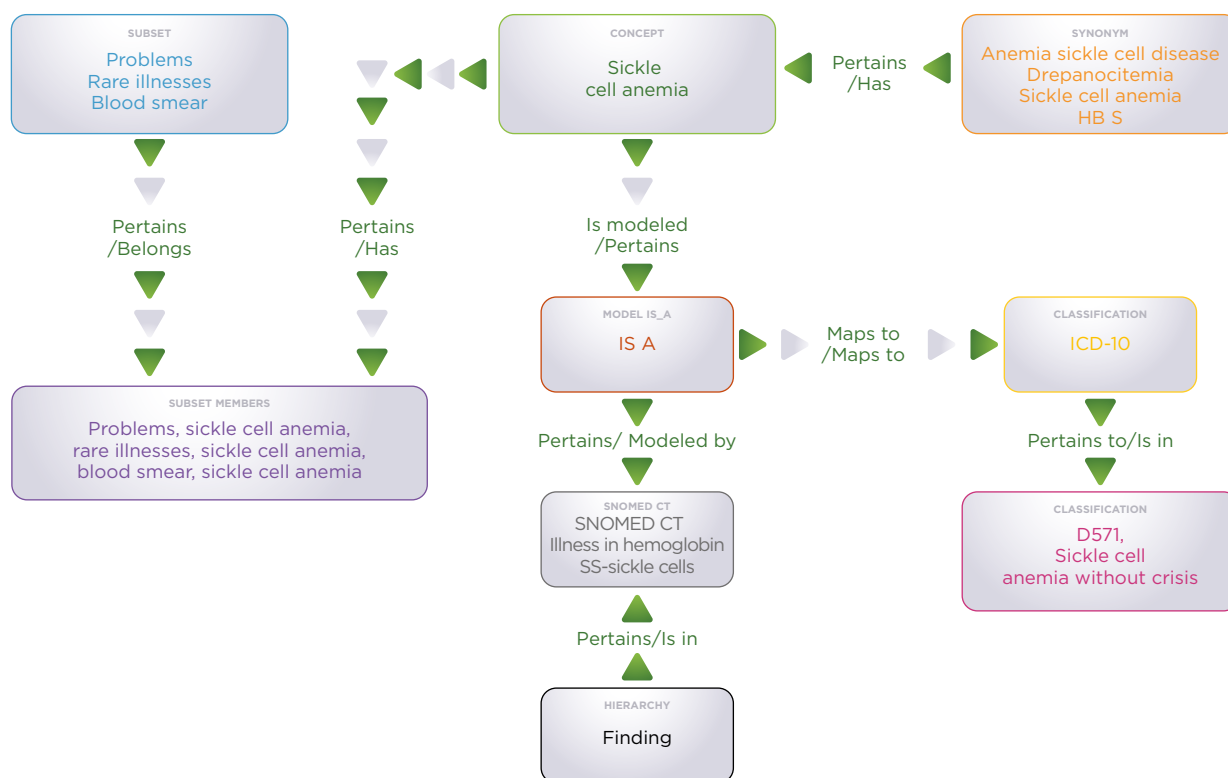
SNOMED CT is organized by basic elements, namely:

- Concepts: the basic units of SNOMED CT, which represent clinical meanings
- Descriptions: the human-readable terms that link to each concept
- Hierarchies: the 19 categories with subgroups that contain all the concepts in SNOMED CT
- Attributes: the properties used to characterize and define concepts
- Relationships: used to interconnect similar concepts within SNOMED CT. There are two types of relationships:
 - Is a relationships (I)
 - Attribute relationships, where there are two related concepts and one explains the value of a defining characteristic of the other

>> Examples:

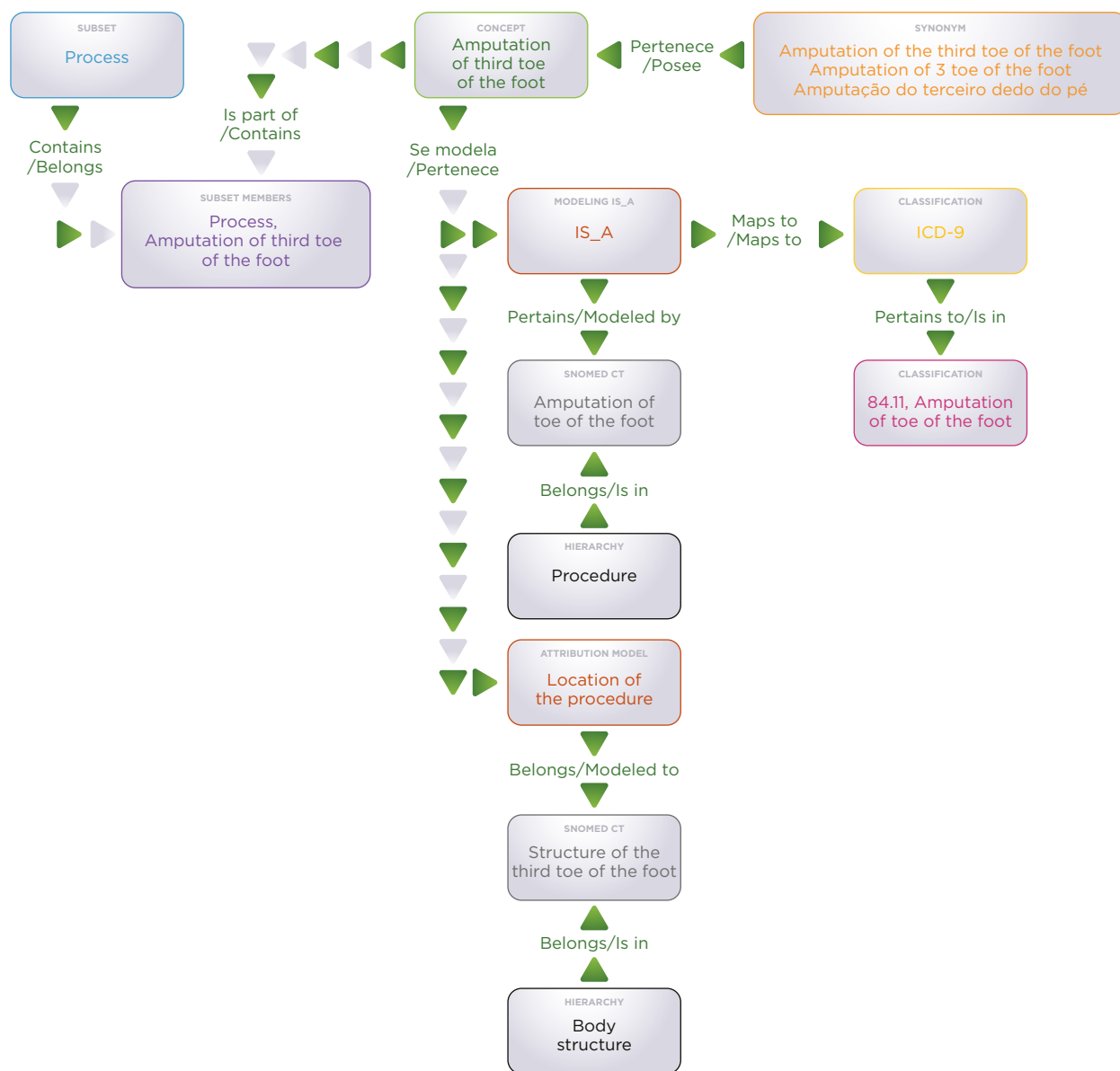
The figure below shows how the sickle cell anemia concept is represented. This concept has four synonyms, of which two are in Spanish, one is in English, and one contains abbreviations. This concept belongs to three sets: Problems, Rare Diseases, and Hematology smears. The concept sickle cell anemia has an is a relationship with Haemoglobin disease SS-sickle cells (SCTID: 127040003). This concept of SNOMED CT belongs to the Findings hierarchy. The mapping of this concept to the ICD-10 classifier is code D57.1, Sickle-cell disease without crisis.

Figure 11. Example of SNOMED CT classification



In addition to the is a relationship, a concept can be modeled with relationship attributes that allow you to specify the representation of the concept. In the following example, the concept AMPUTATION OF THE THIRD TOE OF THE FOOT has the relationship attribute Location of the procedure, with a relationship to the body structure Structure of the third toe (SCTID: 78132007).

Figure 12. Example of SNOMED CT classification



>> Regenstrief Institute

This nonprofit organization associated with Indiana University, in Indiana in the United States, started the Logical Observation Identifiers Names and Codes (LOINC) in 1994 in response to the need to share the results of laboratory studies with providers and health insurers.

LOINC provides universal identifiers for laboratory results and other clinical observations (vital signs, water balance, clinical scores, etc.). LOINC is a free tool for developers (LOINC, n.d.).

>> IHE (Integrating the Healthcare Enterprise)

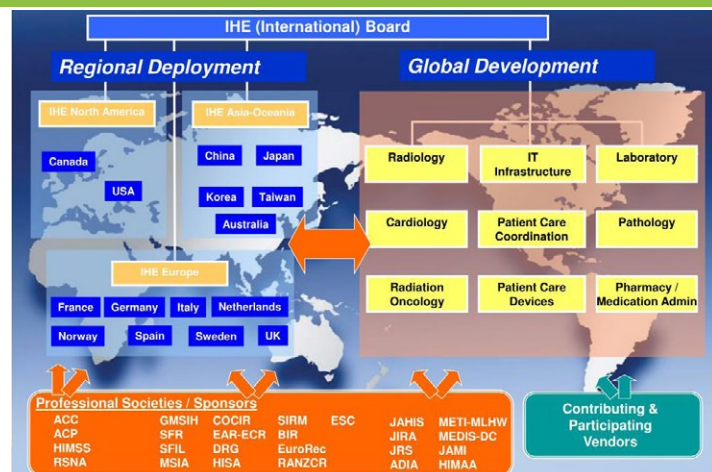
The Integrating the Healthcare Enterprise (IHE) initiative comprises health professionals and industry representatives who seek to improve how electronic medical information is shared through the adoption and specification of standards as well as the testing of products to certify that they meet interoperability requirements.

IHE defines “Integration Profiles” that use existing standards for system integration, providing effective interoperability and efficient workflow. IHE helps organizations reach the level of integration required for EHRs.

Note that IHE is a recommendation to use existing standards, not a standard itself. The organization’s mission is to develop and promote the substance of the recommendation, particularly in terms of medical standards. The IHE has a set of specifications on a variety of healthcare issues that comprise IHE’s Technical Frameworks, and any equipment or software that meets those specifications it is said to be IHE compliant.

IHE International is based in Illinois, in the United States, and is primarily sponsored by HIMSS and the Radiological Society of North America. Its regional, national, and international domains each have their own directory.

Figure 13. Organizational structure of IHE



IHE and the domains have sponsors, with the domains sponsored by medical/professional societies that develop technical solutions to implementation issues. In addition, IHE’s regional implementation committees promote the use of the frameworks within their relevant region and collaborate with local governments and ministries.

Standardized Ehr Models (Openehr)

Before implementing any information system or EHR in health settings, it is essential to have a clear and detailed idea of what it will need to accomplish. It is also essential to have a set of EHR architecture requirements that will serve as the structural framework of the project, defining the components to be used and detailing how to patients' clinical information is to be used. These requirements should be independent of the technology used to develop the software as well as the structure of participating organizations and the care model.

The complexity and particularities of the health field create problems and may cause health informatics projects to fail—a risk that is accentuated by bad, incorrect, or incomplete solutions attempted from **IT and systems engineering departments**.

Various initiatives have attempted to mitigate these problems by giving health professionals the tools necessary to generate their own representation of health knowledge, regardless of implementation.

But these are not models for interoperability—they are models for building medical history systems—so they dictate how the software has to be built. In contrast, interoperability standards do not dictate the content or method of construction of the software, but only the content of the data being exchanged.

The “dual model” is one of the fundamental paradigms on which these architectures are based. It contains stable reference information as the first level of modeling, with formal definitions of clinical content, in the form of archetypes and templates, at the second level. Only the first level is implemented in software, significantly reducing the reliance on working systems and their data on the variable definitions of the content handled by those systems. As a result, systems can be smaller and easier to maintain than systems deployed on a single level. They are also self-adaptive systems, as they are designed to adapt to forthcoming archetypes and templates. An example of such a system is openEHR.

OpenEHR is an open source specification for managing and exchanging electronic medical records. It evolved from a project in the European Union called Good European Health Record (GEHR) within the Advanced Informatics in Medicine program. The OpenEHR framework is based on a two-level modeling approach to separate clinical concepts from the information model.

The first level is the technical one, and it involves the development of the specifications and the implementation necessary to obtain a stable information model. The second level is the clinical one, and it involves domain specialists for the development of ontologies and archetypes based on domain restrictions. this level is also known as the Archetype Model.

The model provides a general framework that can incorporate any clinical information. Archetypes are the rules for specifying clinical data in a specific part of the information model in order to achieve interoperability, and archetypes are also derived and reusable. A collection of archetypes forms a template that can be specific to the needs of an organization.

Are there projects in the region?

Carrying out formal interoperability programs is not easy. While there is already evidence of the usefulness of the implementation of international standards in the field of health, both the public and private sectors in Latin American and the Caribbean have not made progress in this regard.

Globally, a good set of recommendations is presented by the American Network of Cooperation for Electronic Health (RACSEL), which created a space to share and reflect on current experiences with Electronic Health Records (EHR) in the region. The purpose is to generate the first government recommendations to support EHR rollout and discuss regional integration principles. RACSEL has consolidated the experiences of five Latin American countries—Chile, Colombia, Costa Rica, Peru, and Uruguay—and generated thoughtful work around fundamental elements for EHR evolution in the region. RACSEL is an Inter-American Development Bank (IDB) funded Regional Public Good for the advancement of EHR in the region. The document “Health Interoperability Standards – Technical Recommendations” provides an overview of recommendations, standards, and strategies for initiating an interoperability project.

The following table summarizes actual implementations in Argentina, Chile, and Uruguay as insights on interoperability efforts.

Table 1. Implementations of interoperability projects

Project	Objective	Laws	Standards	Leadership
Argentine Health Interoperability Framework (MAIS)  ARGENTINA Scope: REGIONAL	Standardize the exchange of clinical documentation, billing detail, and payments between providers and funders.	No legislation. Run by the organizations themselves to solve the problem of having to maintain numerous interfaces for data exchange.	CDA and FHIR STU3	While it does not have a main sponsor, the NGO USUARIA (Argentinian Association of Information and Communication Technology Users) was the driving force for and organizer of the project.
Salud.uy  URUGUAY Scope: NATIONAL	Make national electronic medical history (HCEN) possible and secure. The HCEN computer platform is in its first implementation version. Its base components include the National User Index (INUS), the interoperability data bus, and the registration and indexing system of electronic documents.	Decree No. 242/017 regulates the electronic processing and exchange of personal information by legally registered public and private health institutions as well as use of the National Electronic Clinical History System and its platform.	HL7 V2, CDA, IHE, and SNOMED CT	Salud.uy is an initiative of the president of the Republic of Uruguay, the Ministry of Public Health, the Ministry of Economy and Finance, and the Agency for Electronic Governance and Information- and Knowledge-Based Society. Salud.uy is the eHealth initiative that promotes intensive information and communication technology (ICT) use in the health sector.
Interoperable medical account  CHILE Scope: NATIONAL	Chile's first public-private effort for information exchange using international standards. The project's objective is to ensure interoperability with standardized transmission of health and financial information between providers and FONASA to ensure business continuity, to ultimately generate gains for beneficiaries.	No legislation. It is an agreement between providers and the main funder of Chile's public health system.	HL7 V2, IHE, SNOMED CT, and ICD	The program's leaders are Health + Development, CENS, and FONASA.

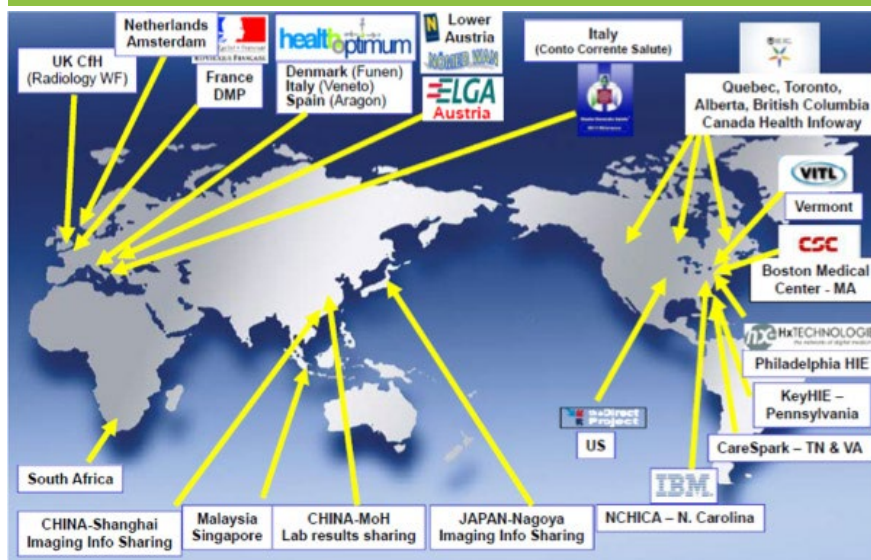
Project	Objective	Laws	Standards	Leadership
National interoperability plan  ARGENTINA Scope: NATIONAL	Part of the universal health coverage implementation, the plan sets out to integrate patient information across the country to manage care, statistical, and epidemiological purposes. This includes shared medical history, exchange of information for records and programs, and continuity of care: electronic prescriptions, clinical orders, and referrals.	<ul style="list-style-type: none"> Resolution No 189/2018 establishes the National Digital Health Strategy 2018–2023. Resolution No. 680/2018 sets the Health Computer Systems Standards. Resolution No. 21/2019 of the Secretariat of National Health Governance, establishes the National Telehealth Plan 2018–2024. Resolution 115/2019 of the Secretariat of Health creates the National Health Interoperability Network. 	FHIR R4, SNOMED CT, IHE, and ICD	National Directorate of Health Information Systems www.argentina.gob.ar/salud
Shared Clinical History (HCC)  CHILE Scope: NATIONAL	The Shared Clinical History is a web based solution that must be integrated with every medical history in the country. The user clicks on a link to open a webpage with information from the national health ministry's database. The Clinical History Summary is for providing patient information to all care providers.	Procurement of components through a ministry of health tender. Frame ID 2239-17-LP11 and 2239-21-LR15	IHE, CDA, and FHIR STU3	Ministry of Health, Undersecretariat of Public Health

Any experiences outside the region?

Many interoperability projects, from the institutional level to those on a continental scale, have been a success.

The most important ones are based on IHE profiles, and the objectives and scope of some of them are shown in Figure 15.

Figure 14. Examples of interoperability projects in the world



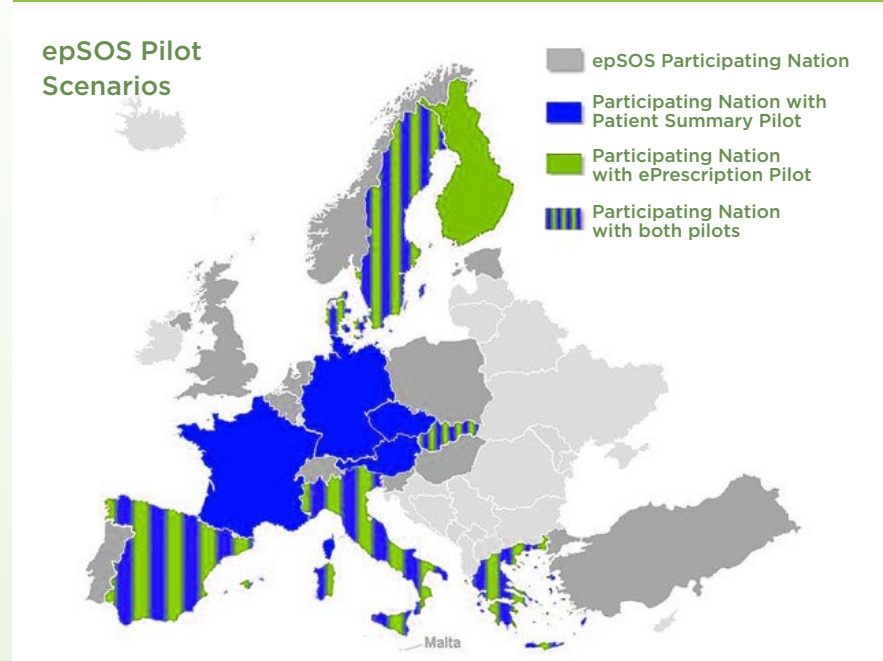
The following four studies of clinical history projects examine the main elements to consider when planning a large-scale implementation, such as objectives, scope, budget, communication tools, and training and development.

European Patient - Smart Open Services (epSOS)

The *European Patients Smart Open Services* (epSOS) project aimed to establish a summary in the electronic medical history so that a professional could quickly consult essential patient information if someone needed assistance outside of their home country. It included functionality for e-prescriptions that allow the patient to receive medication regardless of the country it was prescribed in and the country where it was dispensed.

The project had a continental reach and was tested in 11 countries: Austria, Czech Republic, Denmark, France, Greece, Holland, Italy, Norway, Slovakia, Spain, and Switzerland. In total, 23 countries participated, investing more than 36.5 million euros. The project began in 2008 with the goal of providing interoperability between countries, mainly to accommodate people moving short distances around Europe. The pilot ended in 2014.

Figure 15. EpSOS pilots



The project as coordinated by the Swedish Association of Local Authorities and Regions (SALAR), and the patient and provider education components were carried out through the project's website. It also featured an education and certification component for software developers, with open access to documentation <http://www.epsos.eu>

Although the project is not active, it laid the groundwork for the CDA implementation guides used in many projects. The document structure was standardized, and the content used national global identifiers in addition to the vocabulary and data set determined by the project. The processing of each document was problematic because of the language differences, although epSOS provided translation from Spanish into French through its own vocabulary and semantic services. The patient summary included information on allergies, medications, vaccines, previous illnesses, procedures, vital signs, results, and treatment plans. The terminology in the records depended on the user, as the user was responsible for translating the original information into the relevant language (epSOS – European eHealth Project, n.d.).

The *International Patient Summary* (IPS) is one of the most important projects at the continental level that made use of the lessons learned and advanced with definitions established in epSOS.



International Patient Summary (IPS)

The IPS is itself a consolidated clinical document that provides a clinical data set. The idea is to provide access to this data during unscheduled health care appointments with the objective of ensuring that health professionals have the requisite essential information for patient care.

The IPS has been one of the main results of interoperability work between the European Union and the United States. Since 2010, two major projects addressed the need for patient summaries to have common templates and vocabularies. The European Trillium Bridge project and the HME interoperability working group were formed under the Office of the National Coordinator for Health Information Technology (ONC) Standards and Interoperability Framework (S & I) and as an initiative of the EU-US eHealth Cooperative Initiative.

The Joint Initiative Council (JIC), also known as the Joint Initiative on SDO Global Health Informatics Standardization, started the project with a pilot phase focused on the patient summary, which has since become the roadmap for work between the EU and the US. The goal is to have a standardized IPS by 2020.

In April 2014, ONC started the first IPS standardization project—which was also called International Patient Summary, although the acronym was INTERPAS—under HL7. In May 2016, the European Commission granted an agreement through CEN/TC 251 that recognized the need to support and participate in the development of IPS standardization activities. With new momentum from the European Commission and ONC, in May 2016 a review of the HL7 project was initiated as well as standardization of the European Patient Summaries standards by CEN/TC 251.

At this point, the initiatives were run as a single IPS project backed by different organizations with CEN/TC 251 and HL7 teams working together. The organizations also agreed to establish informal collaboration to speed up the process by initiating continuous alignment of the two projects. The first IPS implementation was based on HL7 CDA R2 and later on FHIR (HL7 IPS IGs) (IPS, n.d.).

The purpose of this implementation guide (HL7 IPS IGs) is to identify the clinical data, vocabulary, and set of values needed for an international patient summary. The summary is specified as an HL7 CDA R2 document to which templates are added.

The IPS includes information such as allergies, current medications, and patient problems. The data are presented concisely, presenting basic information for the clinician. The CDAs contain general information about the patient (name, date of birth, gen-

der, etc.), the document itself (when and how it was created, the last update and who made it, etc.), and an information summary with details such as allergies, current medical problems, implants and major surgical procedures during the last six months, and the current medication list.

This implementation guide was based on the results of multiple previous projects on patient summaries (such as epSOS, ONC Standards and Interoperability Framework, Trillium Bridge, Sequoia eHealth Exchange). It also provides rules and recommendations for vocabularies, including multilingual configurations and templates.



PCEHR – (Personally Controlled EHR) or My Health Record

Another important implementation is the My Health Record project, which was initially known as PCEHR (Personally Controlled EHR) of Australia. The objective of the project is to resolve information fragmentation of national records, allow people simpler access to their clinical data, and make providers' access to patient information more secure.

The project was implemented throughout the country, with an investment of more than US\$466,000,000 and 243 participating organizations, with the goal of ensuring every citizen had access in 2018. To achieve this, a registry was created that allowed every citizen the option to opt out. About 90 percent of the population uses the portal (My Health Record, n.d.).

Legally, My Health Record is administered by the Department of Health, and, in essence, by all Australians. It was developed primarily by the National E-Health Transition Authority and has an education center and websites to train providers and patients. Software developers can access all specifications, examples, and seminars, although there is no product certification yet.

Each health record has a national health identifier and uses unique global health identifiers for patients, providers, and organizations. There are also guides on the types of documents in the record (evolution, medical case history summaries, etc.), guides on how to use each type of document or present them to the user.

The specifications establish how certain forms should be structured, such as a hospital discharge letter, the clinical history summary, medication usage guides, consultation and referral requests, and office visit summaries and directives. Each guide specifies the requisite vocabulary and code set per document, either SNOMED CT and LOINC, as well as Australia-specific codes for sex, name, cause of death, mental state, etc. (May, 2005).



Shared Medical Record in Catalonia

Spain has many regional health initiatives of note, but one of the most important is HC3, the Shared Medical Record in Catalonia. The objective of HC3 is to establish an electronic record comprising documents with information on the status and evolution of the patient's condition during treatment. The records are accessed about 74,000 times a month, and 468 organizations use the system. Many types of software are compatible with the system, which contains more than 51 million published documents.

TicSalut, the Department of Health of Catalonia, manages HC3 and assists providers who cannot connect to the system, including in the case of a missing intermediary product or interface. Although providers must generate documents for HC3, patient participation is optional.

Patients access their information with an identification card (the Catalonia CIP card). The documents in the system can also be accessed using national or European identification. Storage takes place in a central repository and multiple local repositories. The data are stored in a central warehouse as well as several smaller repositories, and each document's registration is centralized. Document transport occurs through web services, simple object access protocol (SOAP), IHE, or other specified web services, and all documents are digitally signed and support all DICOM objects.

CDA R2 is the standardization structure for all documents and templates, which include:

- Registration reports
- Emergency discharge reports
- Nursing reports
- Outpatient consultation notes
- Imaging reports
- Laboratory and pathological anatomy reports
- Vaccination records
- History summaries

The records are encoded with SNOMED CT (Catalan version is administered by TicSalut), ICD-9, ICD-10, NANDA (for nursing), Spanish Society of Medical Radiology (Sociedad Española de Radiología Médica, for imaging), and LOINC for document types and laboratories.

The document contents include unique global health identifiers for each patient and provider as well as local vocabulary administered by TicSalut. The documents are processed through a specific portal or through the medical record, depending on functionality, and Spanish law defines the specifications for document types, templates, text, and structure (Solans, n.d.).

Conclusions

Interoperability is an essential attribute of information systems for modern health management—even though it is imperceptible to users when done correctly since it allows for the free flow of applications and systems without user intervention. The benefits of designing interoperable systems are numerous, ranging from integrating patient data to providers' decision-making processes to the universal information access to a real-time collection of statistics, indicators, and other critical data. Interoperability also allows different applications and systems to interact without having to modify their structure.

It is critical to think about interoperability when planning a health information system. Aligning information management and organizational management with the goals of the information system and its users is critical to success.

A health service must understand that several options for information systems already exist. The new system can be taken in its entirety from an existing model, be a modification of one, or be created entirely from scratch. Regardless of their decision on system format, organizations must also meet a number of basic requirements, such as having unique patient identifiers, developing and maintaining master performance tables, using homogeneous formats and nomenclatures to register information, and applying security measures to ensure data confidentiality. This organizational task is often equally difficult or more difficult to carry out than the system design.

Systems that are defined for information exchange should include both clinical and technological teams, as the former must have an important role in decision-making.

The first strategic step is to understand the current IT environment. There is probably already a significant amount of software generating a lot of information every day, but it is often running on parallel systems that do not communicate with each other or speak the same language. Inevitably, this information cannot be used in its entirety. In addition, it is very common in the region,

mainly outside of big cities, to have insufficient internet access or speed needed for achieving interoperability.

To address these issues, certain issues need to be prioritized:

Choose which standards to use.

What will be the standards for exchanging information and the vocabulary used in the project? What infrastructure will be available? How will centralized patient identification be structured? How will clinical documents be shared and indexed to support ongoing patient care? In addition, other projects in the country or health ministry that need to be part of the integration must be considered, such as vaccine registers, medication programs, chronic disease registers, and national directories.

Promote the development of regional information systems and their integration.

Some organizations will need help making the first step toward interoperability, while forward-thinking organizations may need help only on specific sticking points. The key is to have specialized consultants and equip them with tools for early adoption, looking at ways to strengthen the autonomy of provincial and municipal social services as well as issues under private sector jurisdiction.

Ensure data privacy and confidentiality.

This process must include patient access to their data and giving them the ability to give or withhold consent for sharing the data. Accordingly, policies will have to be defined about building patients' trust in the system, such as knowing who has access to the data.

Resolve legal and regulatory concerns.

Some people doubt the validity of electronic records. The aim of an interoperability project is, therefore, to use a digital health law as a framework for the project, then put the patient at the center of the project structure and respect their rights and desires. A lot of work should be done to clearly define these issues for patients, particularly with regard to the data privacy and security standards chosen.

Human capital development.

It is necessary to create specialized training sessions for all users of health systems in order to communicate the validity of the new system, its challenges, the changes involved, and other issues.

Everyone must be trained, from doctors to patients to administrators. The goal of the training is to reduce barriers to change and reduce the fear of the new system, and project leaders must be named to help shepherd the process.

Interoperability goes far beyond institutional walls. It can encompass interinstitutional, national, and international efforts, which means that interoperability efforts must consider how to communicate with all levels of different regions and countries. As such, it is advisable to rely on national and international policies that define an interoperability framework in which to work.

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