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UNIVERSITY OF EASTERN FINLAND

eHealth4all@EU

Interprofessional European eHealth Programme in Higher Education

IO5: European Summer School on eHealth – Course Material

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- Osnabrück University of Applied Sciences, Health Informatics Research Group
- Osnabrück University, New Public Health Research Group
- University of Eastern Finland, Research Group of Health and Human Service Informatics (HHS)
- University of Porto, Centre for Health Technology and Services Research (CINTESIS)

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Osnabrück, January 2023

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Abstract

In September 2022, the interprofessional European Summer School on the topic “Information in Healthcare – From Data to Knowledge” was held at the University of Porto. This Summer School included the topics Interoperability, Data Protection and Security and Data Analytics and consisted of an online preparation phase and an attendance phase in Porto. The didactic concept involved problem-based learning using a case study. A variety of course materials were developed and used to achieve the learning objectives. There are plans to continue the Summer School concept at participating institutions in the future, starting with a Spring School 2023 in Osnabrück.

1 Introduction

The fifth intellectual output focuses on organizing and running a European Summer School on Interprofessional eHealth Education, giving teachers and graduate students (Masters and PhD) the opportunity for face-to-face, cultural interaction and learning. Similar to the online courses, the topics of Interoperability, Data Protection and Security and Data Analysis were addressed. In the following, we will briefly explain why these topics are of great importance and were considered in the Summer School.

With the advent and diffusion of electronic health record systems a wealth of patient data has become available. In principle, these data can now be shared among the relevant care provider to **ensure continuity of care** across shifts, departments, institutions, settings and countries. Furthermore, they can be analysed for **secondary use** particularly for generating new knowledge, for quality development and for management purposes such as resource management. While these new opportunities promise improvements at all levels there are barriers to put the new digital scenarios into practice.

Many digital patient data are hidden in pdf documents in an unstructured and not machine-readable way. They can be shared digitally among the providers but cannot be analysed without additional efforts. To this end, the data have to be structured, coded and classified according to standards that are common in the national and international

community. Thus, in order to share data, the information systems have to ensure **full interoperability**.

Apart from the technical access to patient data through interoperable systems, there is the question of the **legal foundation** of accessing and sharing data. Patient data are personal data and highly sensitive. They are subject to data protection compliant with the **European General Data Protection Regulation** and other regulations, e.g. obligation to secrecy of health professionals. At the same time data must be securely managed so that they are integer, i.e. free from being manipulated or destroyed, and available for those who are entitled to access them.

Given the technical and legal accessibility of data, they can be shared and analysed. The opportunity to **analyse data** is strongly associated with the concept of a **Learning Health System** (LHS). An LHS is meant to support the generation of new knowledge including the verification of knowledge with local or regional data. Such new insights can be employed for quality management, process optimization, resource allocation and research. An LHS makes use of these findings by drawing conclusions and implementing change. This circumstance leads to new data that then can be further analysed and interpreted.

2 Methods

The Summer School took place at the University of Porto in Portugal from 09-13 September 2022. The actual Summer School was preceded by a self-study phase. Materials on the three topics were made available in Moodle as preparation. The students were able to work through this material independently and self-determined according to their needs. The following figure provides an overview of the Summer School concept:

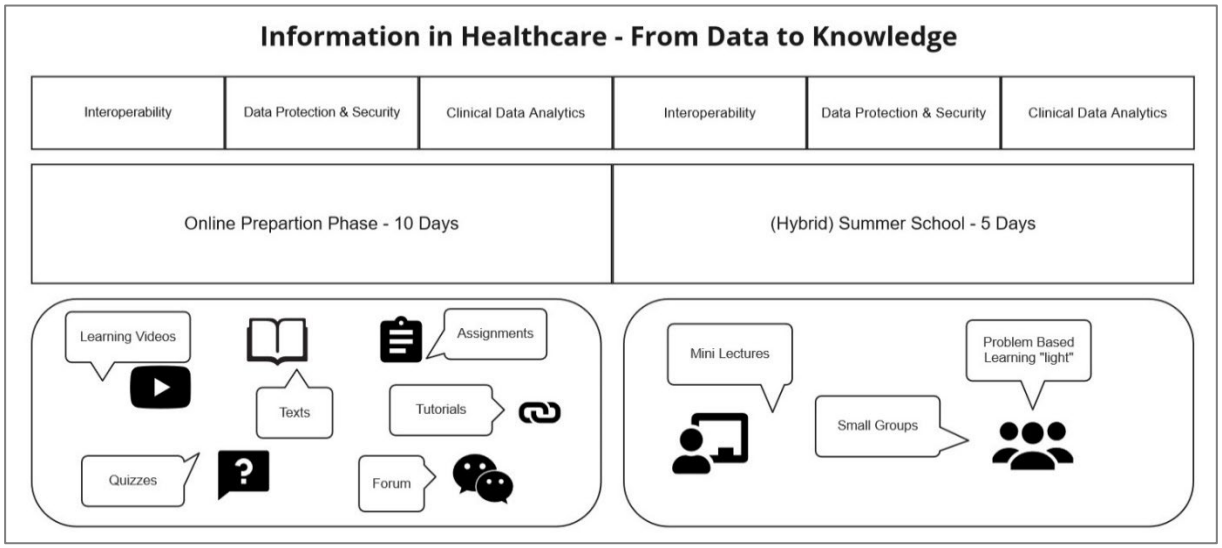


Figure 1: Concept of the Summer School

3 Results

The expected learning outcomes were defined as to explain the value of interoperable data and law-compliant data management for secondary use of patient data and to practically apply the knowledge in selected cases via problem-based learning:

Table 1: Learning goals for the three courses

Interoperability (UP)	Data Protection & Security (UEF)	Data Analytics (HSO)
To understand the key elements of structural/ semantic interoperability.	To understand the meaning of privacy, confidentiality, integrity and security for processing personal data.	To develop a statistical prediction model using logistics regression.
To understand the main concepts of HL7 FHIR and apply them in a clinical case.	To analyse these legal and ethical requirements and explain how they can be implemented.	To interpret the findings in terms of their applicability for clinical decision support.

UP = University of Porto / UEF = University of Eastern Finland / HSO = Osnabrück University of Applied Sciences

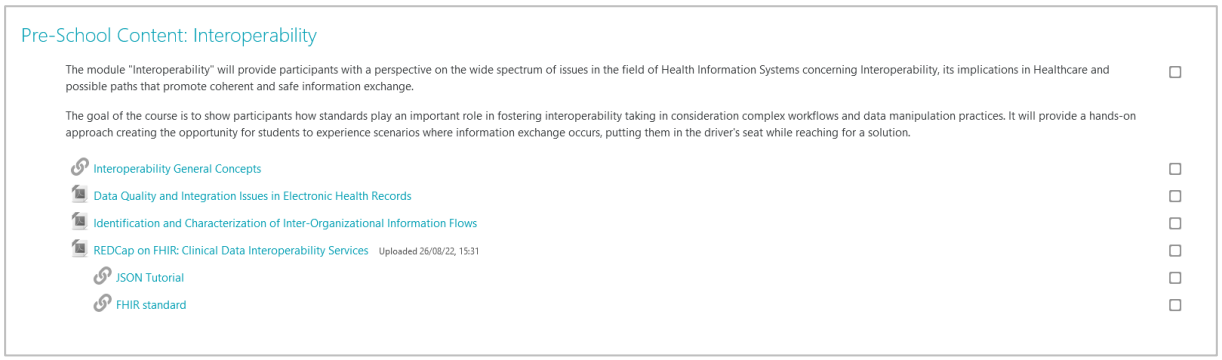
The course was based on the following overarching case, which served as a practical application of the theoretical content:

A group of doctors and nurses from primary and secondary care wished to improve the quality of care by early detecting patients at risk for diabetes. To do so, patient data from two different types of electronic patient records had to be merged. It was unclear whether they were allowed to share the patient data across settings. Finally, they wanted to develop a risk prediction model from their own data and compare it with the literature.

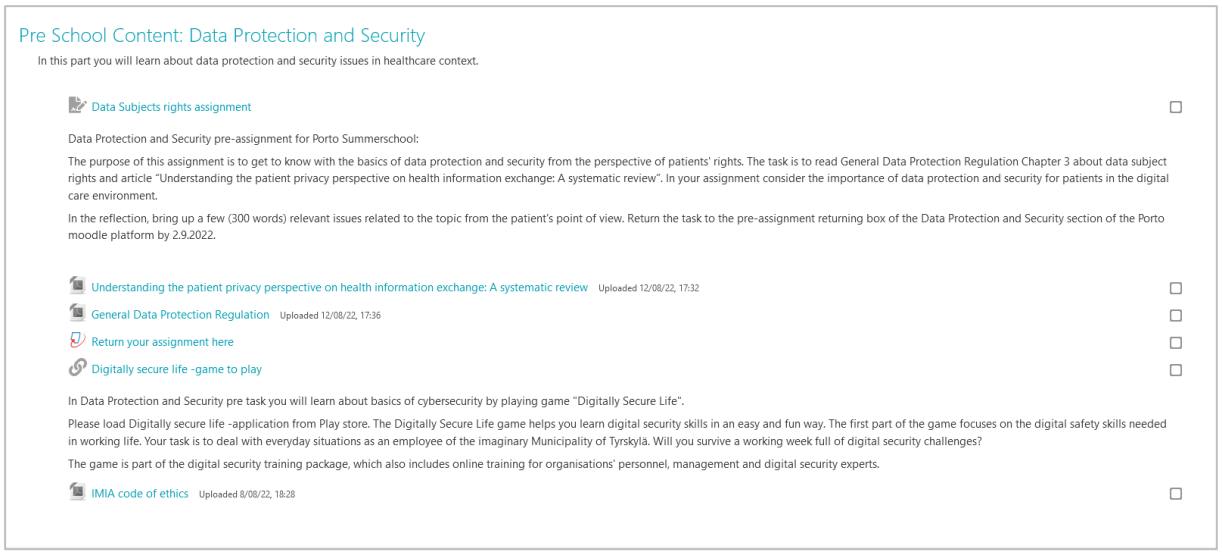
A variety of materials were developed and used to accomplish these learning objectives.

Pre-school content

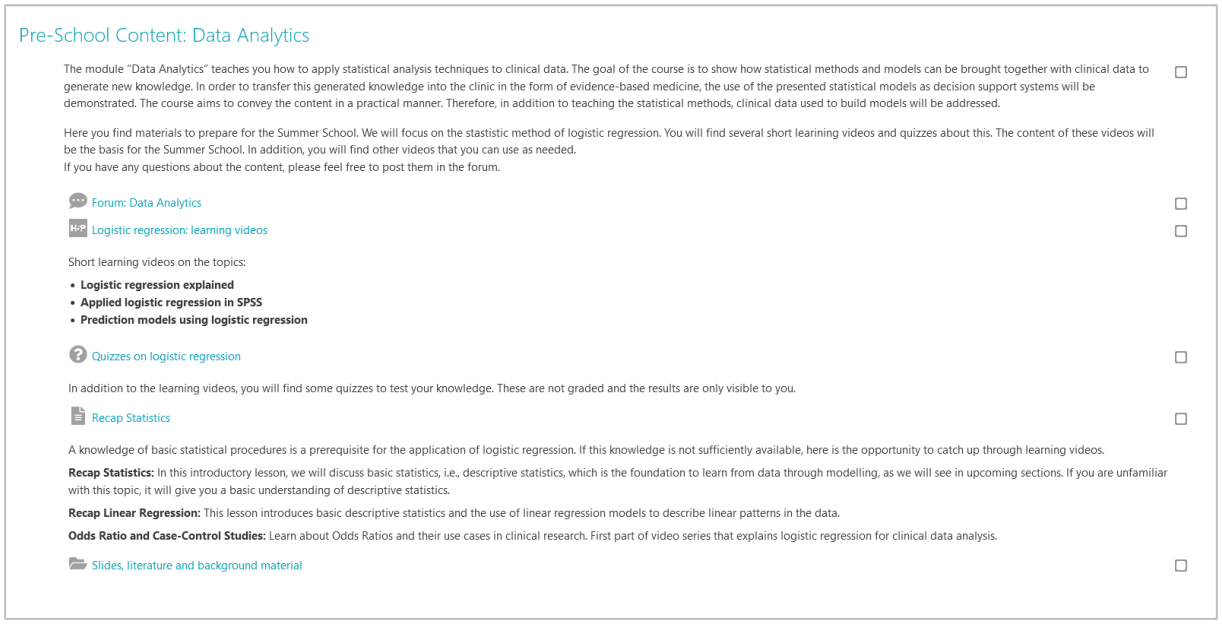
Interoperability (UP)



Data Protection and Security (UEF)



Data Analytics (HSO)



Face-to-face Summer School content

Table 2: Face-to-face Summer School content

Interoperability (UP)
Module Description Interoperability
Context Paper: Cruz-Correia RJ, Pereira Rodrigues P, Freitas A, Caranrio Almeida F, Chen R, Costa-Pereira A. Data Quality and Integration Issues in Electronic Health Records. 2009.
Context Paper: Pinto E, Brito AC, Cruz-Correia RJ. Identification and Characterization of Inter-Organizational Information Flows in the Portuguese National Health Service. Appl Clin Inform. 2016;7:1202-1220.
Context Paper: Cheng AC, Duda SN, Taylor R, Delacqua F, Lewis AA, Bosler T, Johnson KB, Harris A. REDCap on FHIR: Clinical Data Interoperability Services. Journal of Biomedical Informatics. 2021;121.
Presentation: Health Information Systems Context - Interoperability
Presentation: A gentle introduction to FHIR
Exercise: Interoperability – Challenges Day 1: Interoperability in General
Exercise: Interoperability – Challenges Day 2: FHIR
Data Protection and Security (UEF)
Presentation: Data protection and security
Presentation: Data protection and security – case learning 2022
Report: Independent Security Evaluators. Securing Hospitals. February 23, 2016.
The IMIA Code of Ethics for Health Information Professionals
Factsheet: Digitalization supports health and wellbeing
Data Analytics (HSO)
Module Description Data Analytics
Miro-Board (Screenshot)
Presentation: The Learning Health System
Presentation: Clinical Data Analytics: From Data to Knowledge

The files highlighted in bold are in the Appendix.

4 Conclusion

The concept of the Summer School with the preliminary online preparation phase has proven to be useful. The methodology of problem-based learning in a highly condensed form has contributed to knowledge transfer and was rated positively by the participants. Though the three topics were very challenging and the material provided was extensive, the Summer School has proven to be a successful method of dealing with such topics in interprofessional student groups.

The concept of the Summer School is to be continued, hence a Spring School at the Osnabrück University of Applied Sciences (Germany) and a Winter School at the University of Eastern Finland in Kuopio are being planned.

Appendix: Course Material

Appendix I: Interoperability

Appendix II: Data Protection and Security

Appendix III: Data Analytics

Appendix I: Interoperability

Module Description Interoperability

Presentation: Health Information Systems Context – Interoperability

Presentation: A gentle introduction to FHIR

Exercise: Interoperability – Challenges Day 1: Interoperability in General

Exercise: Interoperability – Challenges Day 2: FHIR

Module Description

Title: Interoperability – From Information Modelling to playing with FHIR
Date / Time: Friday 09:00 – 15:30, Saturday 9:00 – 17:00
Lecturers: Pedro Marques; Ricardo Correia; João Almeida

Background: Health information management is complex and highly dynamic. To fully explore the potential of information, it must be available and ready to use. This is not always an easy task to accomplish given the highly heterogeneous and complex nature of the generated data. Health information standards play an essential role in coping with this scenario. In this course, we will experiment with the standards development process and practice using the FHIR standard to represent and deal with heterogeneity in information representation. We will make use of use cases to promote a hands-on approach.

Objectives / Learning Outcomes:

After the course, you will understand how standards play an essential role in fostering interoperability. I will show the broad spectrum of problems in the health Information Systems interoperability field, its implications in healthcare and paths that promote coherent and safe information exchange.

After the course, you will be able to:

- To understand the importance of interoperable health information systems for obtaining data that can be analysed
- To understand the key aspects for structural and semantic interoperability can be achieved and the critical role of standards in achieving this successfully
- To learn the primary constructs of HL7 FHIR and apply them to a clinical information exchange scenario.

Methods:

Before the start of the course, you will have access to reference papers that will contextualise the health information systems-rich environment.
A set of short lectures promoting interaction will be given during summer school. After that, you will be put in the driver's seat while reaching for solutions for use cases related to health information exchange. These exercises will occur both individually and, in a group, always supported by the teaching staff.

Interoperability

Why, how, who

By Ricardo Cruz Correia

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Contents

1. Complexity of the health sector
2. Data flows
3. Interoperability levels & Specialists needed
4. Existing Standards and Institutions
5. Challenges and Opportunities

Complexity of the health sector

A National Health System

The Portuguese Example

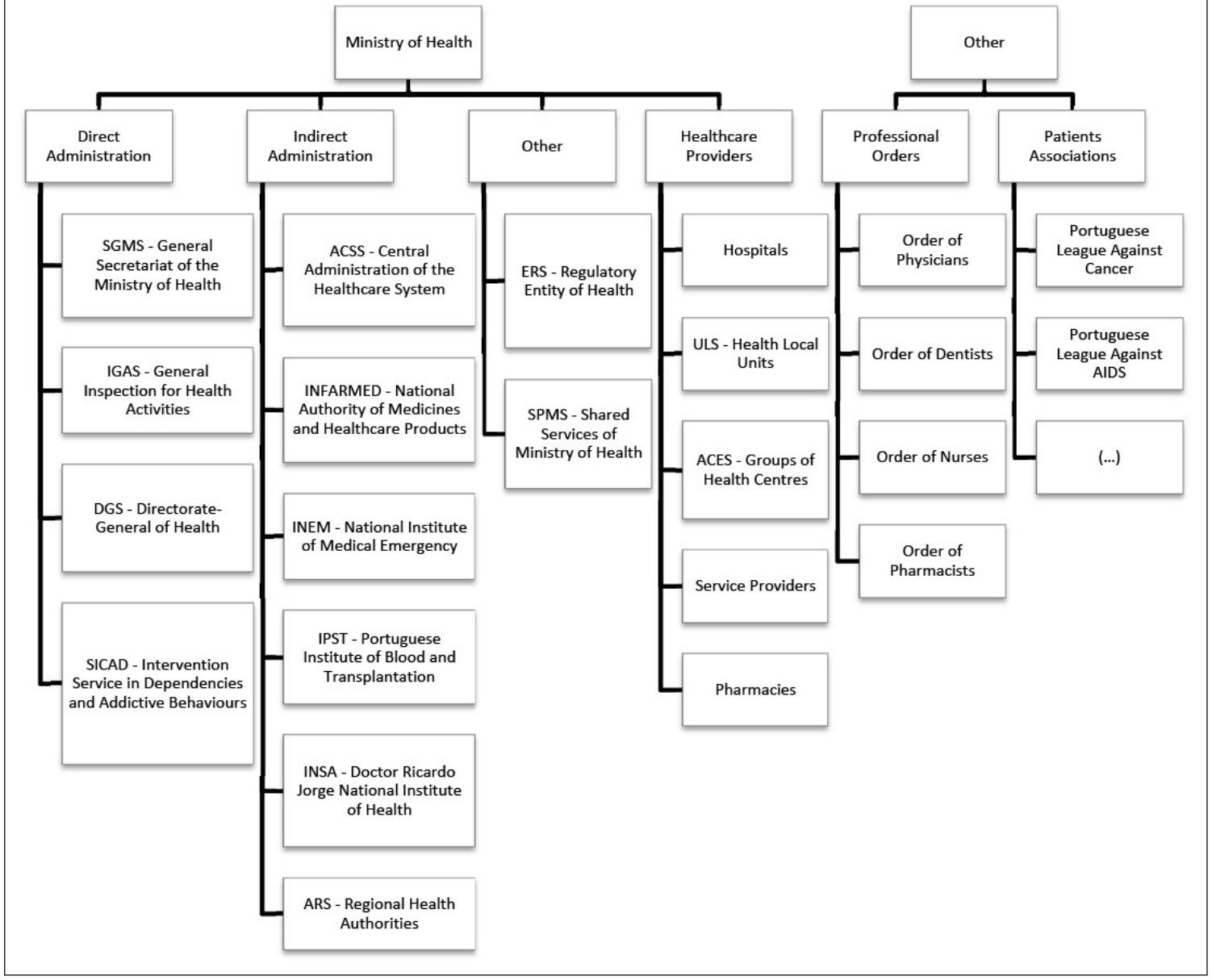
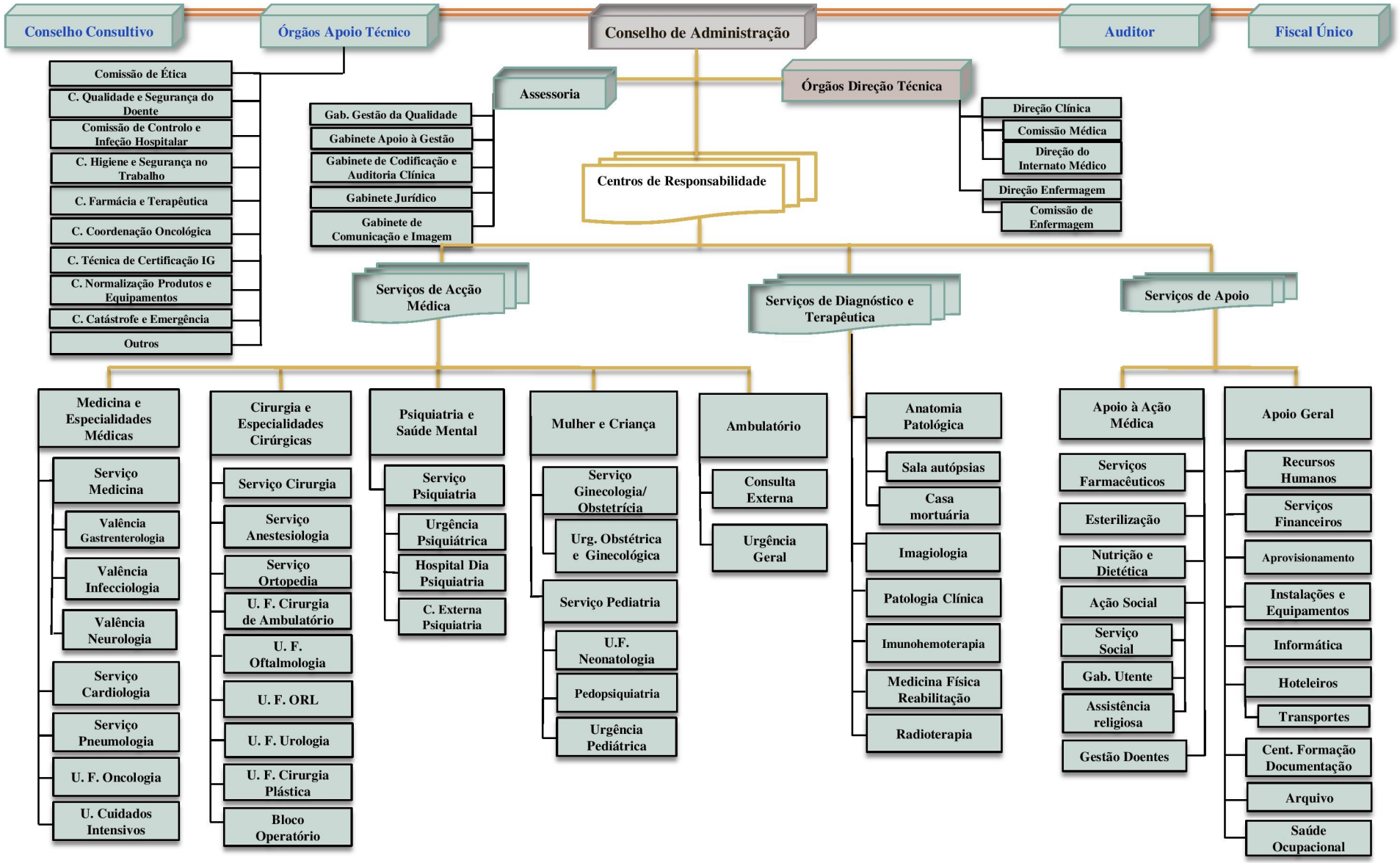


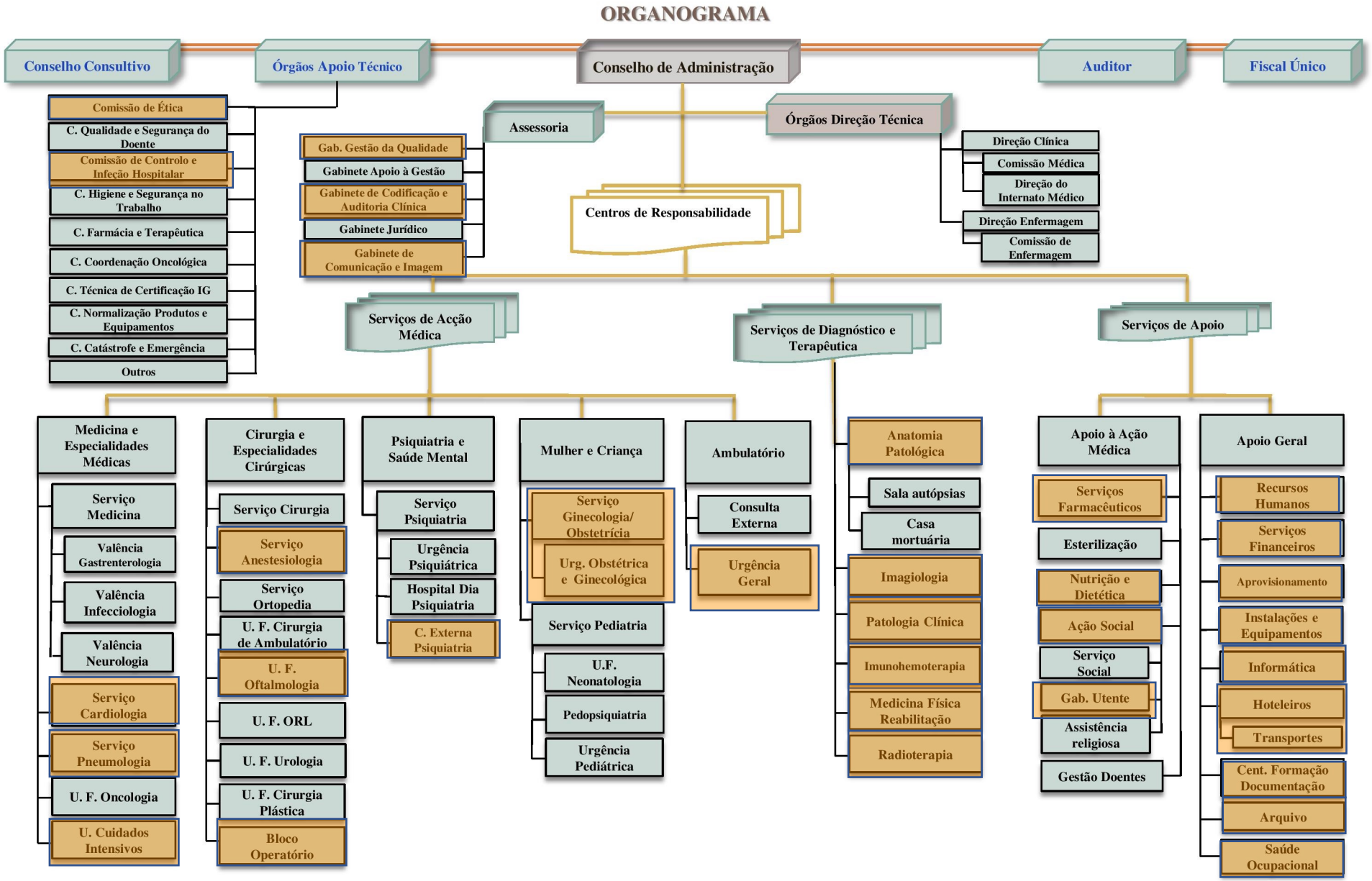
Fig. 1 Organic structure of the Portuguese National Health Service. As expected, the Ministry of Health plays a relevant role but delegates several specific competences in other entities that are under direct or indirect supervision. Most of those are entities with national scope (except the ARS) that are required to develop initiatives or manage a certain area (e.g. INFARMED, INEM, etc.). Other relevant entities are the professional orders on one way and the Patient Associations on the other. The first usually works on regulating the profession and the second providing assistance and disseminating information with patients with a specific disease.

Pinto, E., Brito, A. C., & Cruz-Correia, R. J. (2016). Identification and Characterization of Inter-Organizational Information Flows in the Portuguese National Health Service. *Applied Clinical Informatics*, *7*(4), 1202–1220. https://doi.org/10.4338/ACI-2016-08-RA-0135

ORGANOGRAMA



Organigrama do Hospital do Barreiro. Accessed in May 2021. Available at: http://www.chbm.min-saude.pt/attachments/article/328/organograma_chbm_v2.pdf

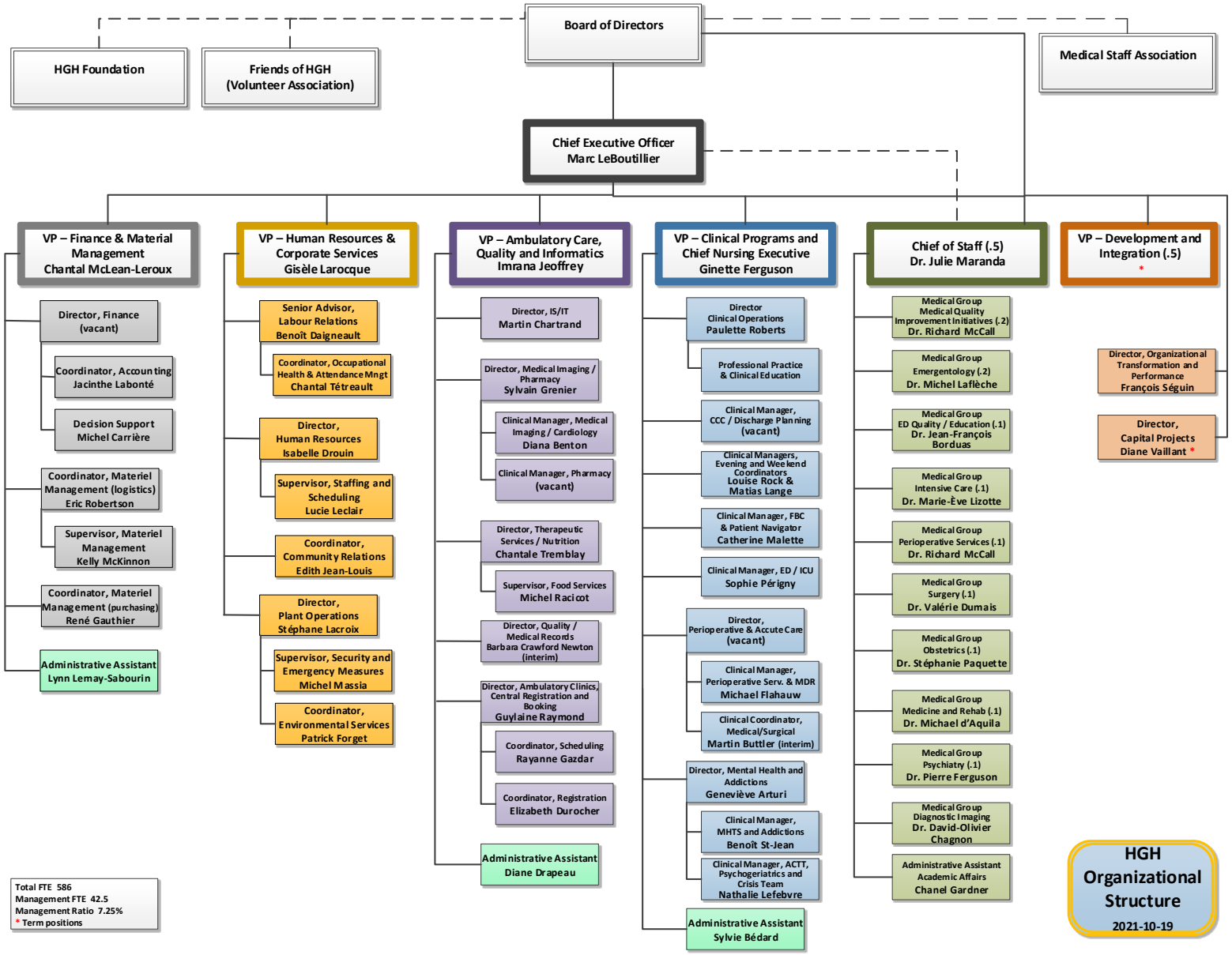


Examples of areas with specific SW

Organigrama do Hospital do Barreiro. Accessed in May 2021. Available at: http://www.chbm.min-saude.pt/attachments/article/328/organograma_chbm_v2.pdf

Hawkesbury and District General Hospital

https://hgh.ca/about-hgh/leadership-team/organizational-structure/



Data flow

Need for communication

Think for use cases the need for comunication between each of the following pairs

1. Hospital ⇔ Regional Health Authorities (ARS)
2. Hospital ⇔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ⇔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ⇔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ⇔ Directorate- General of Health

Need for communication

Think for use cases the need for comunication between each of the following pairs

1. Hospital ⇔ Regional Health Authorities (ARS)
    1. => Number of available beds
    2. <= Number of deaths in region
2. Hospital ⇔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ⇔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ⇔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ⇔ Directorate- General of Health

Need for communication

Think for use cases the need for comunication between each of the following pairs

1. Hospital ⇔ Regional Health Authorities (ARS)
2. Hospital ⇔ National Authority of Medicines and Healthcare Products (Infarmed)
    1. => Adverse Drug Reactions
    2. <= List of Drugs than can be prescribed in hospitals
3. Shared Services of Ministry of Health (SPMS) ⇔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ⇔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ⇔ Directorate- General of Health

Need for communication

Think for use cases the need for comunication between each of the following pairs

1. Hospital ⇔ Regional Health Authorities (ARS)
2. Hospital ⇔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ⇔ College/Order of Nurses (Ordem dos enfermeiros)
    1. <= List of nurses and their professional ID
4. Hospital ⇔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ⇔ Directorate- General of Health

Need for communication

Think for use cases the need for comunication between each of the following pairs

1. Hospital ⇔ Regional Health Authorities (ARS)
2. Hospital ⇔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ⇔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ⇔ Central Administration of the Healthcare System (ACSS)
    1. => List of hospital encouters for reinbursement
5. Portuguese League Against Cancer ⇔ Directorate- General of Health

Need for communication

Think for use cases the need for comunication between each of the following pairs

1. Hospital ⇔ Regional Health Authorities (ARS)
2. Hospital ⇔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ⇔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ⇔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ⇔ Directorate- General of Health
    1. => Cancer Screening results
    2. <= List of people to be screened

The need for communication in NHS

Clinical Information

- Referals
- Exams
- Prescriptions

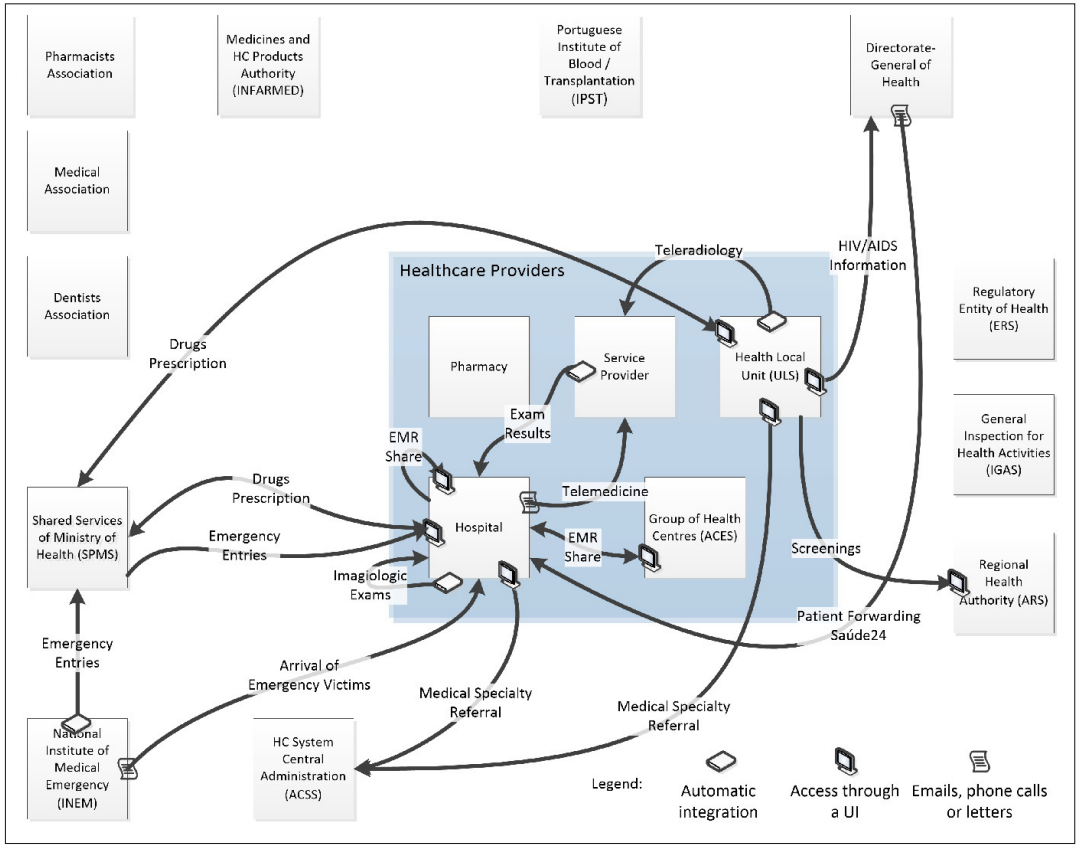


Fig. 3 Representation of clinical information flows elicited from the interviews. As expected, the healthcare providers have a special preponderance.

Pinto, E., Brito, A. C., & Cruz-Correia, R. J. (2016). Identification and Characterization of Inter-Organizational Information Flows in the Portuguese National Health Service. *Applied Clinical Informatics*, *7*(4), 1202–1220. https://doi.org/10.4338/ACI-2016-08-RA-0135

Demographics

- Patient Identification
- Professional Indentification

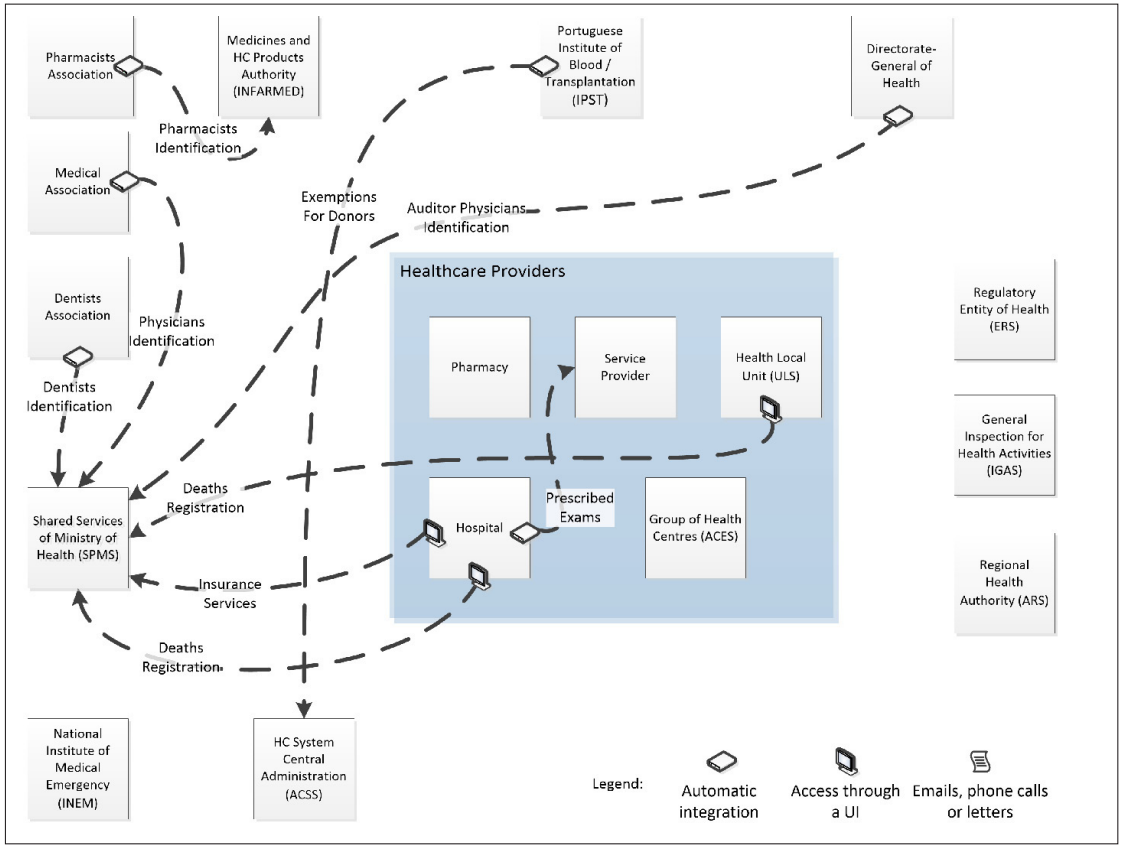


Fig. 4 Representation of information flows that allow identification of professionals or patients usually based on demographic data and in which SPMS plays a significant role.

Statistics

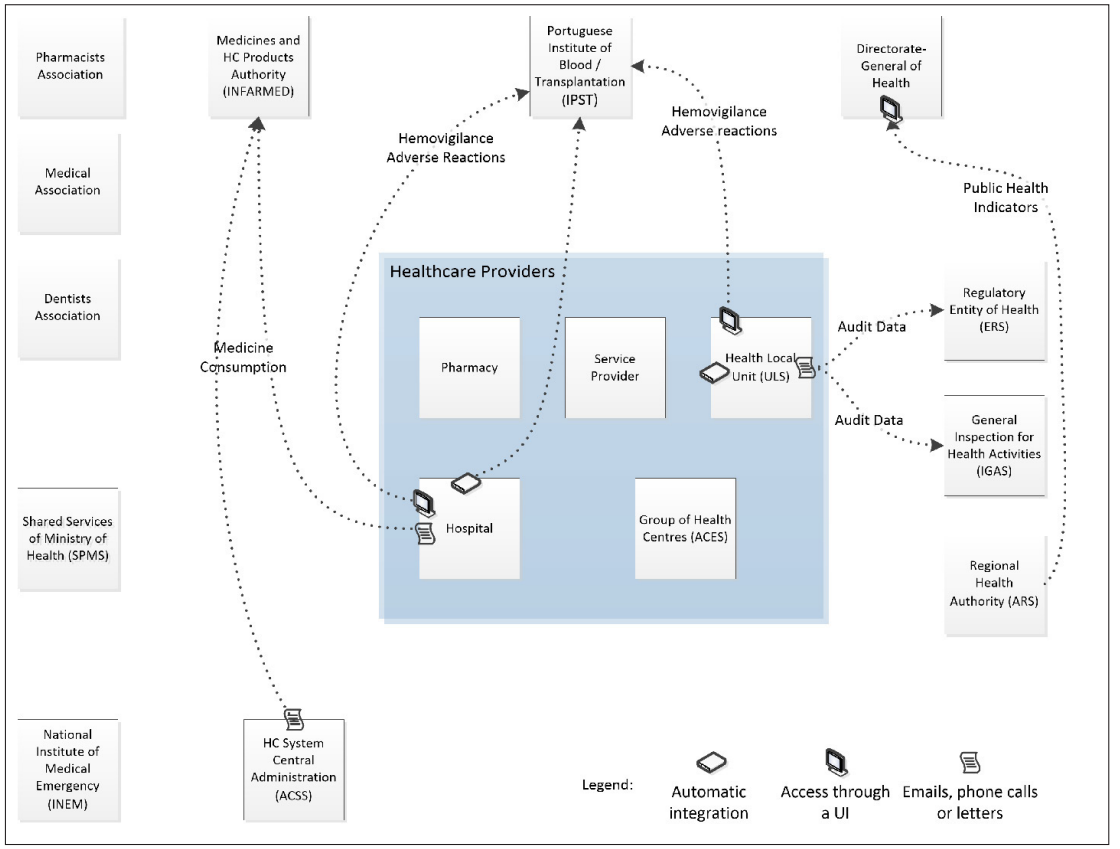


Fig. 5 Representation of statistical information flows that are generally related with audit data or public health concerns.

Pinto, E., Brito, A. C., & Cruz-Correia, R. J. (2016). Identification and Characterization of Inter-Organizational Information Flows in the Portuguese National Health Service. *Applied Clinical Informatics*, *7*(4), 1202–1220. https://doi.org/10.4338/ACI-2016-08-RA-0135

Administrative

- Billing
- Salaries
- Catalogs
- Indicators

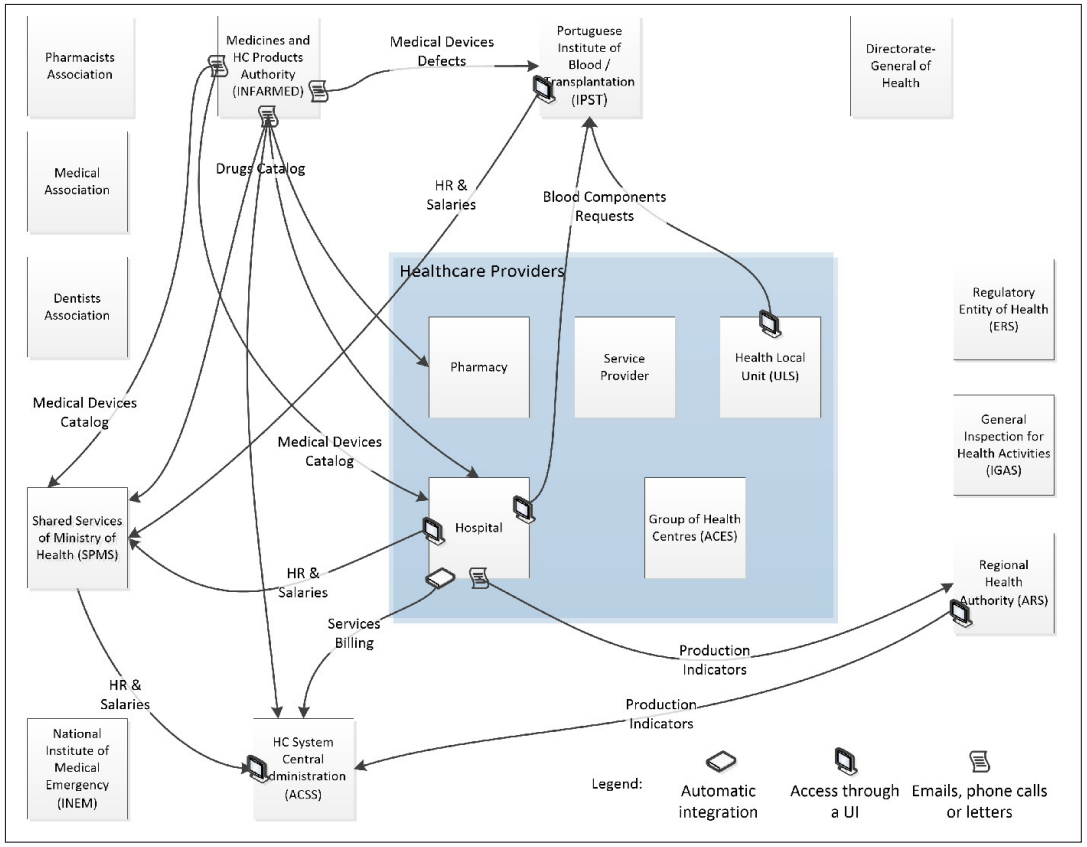


Fig. 2 Representation of administrative information flows elicited from the interviews in which INFARMED has a special preponderance.

Pinto, E., Brito, A. C., & Cruz-Correia, R. J. (2016). Identification and Characterization of Inter-Organizational Information Flows in the Portuguese National Health Service. *Applied Clinical Informatics*, *7*(4), 1202–1220. https://doi.org/10.4338/ACI-2016-08-RA-0135

The need for communication inside a hospital

List of available IS

- Many IS exist in hospitals (~ 50)
- Exchange of data amongst them is very important to improve workflow

(page 1)

Tabela resumo de Sistemas de Informação no CHVNGE

Sigla SI	URL SI	Nome SI	Descrição SI	Tipo de SI	Serviço / Especialidade	Fornecedor	NIF Fornecedor	Entidade adjudicatária	NIF Entidade Adjudicatária	Interoperabilidade
Astraia	URL	Astraia	Base de dados Obstetrícia e Ginecologia.	Internamento	Neonatalogia	Astrimed	507007867	ASTRIMED-Informática e Tecnologia Médica,Lda.	507007867	HL7
B-Anestesic	URL	B-Anestesic	Anestesia e Cuidados Críticos	Cirurgia	Anestesia & Cuidados Críticos	B-Simple - Sistemas de Informação, Lda.	506188841	B-Simple - Sistemas de Informação, Lda.	506188841	#N/D
B-ICU-CARE	URL	B-ICU-CARE	Cuidados Intensivos	Urgência	Cuidados Intensivos	B-Simple - Sistemas de Informação, Lda.	506188841	B-Simple - Sistemas de Informação, Lda.	506188841	HL7
CIT	URL	Certificados de Incapacidade Temporária	Registo e emissão de CIT pelos profissionais de saúde médicos; uma plataforma de interoperabilidade para receção de CIT de SW de outros fornecedores;	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	#N/D
docBase	URL	docBase	Manutenção da Solução Gestão de MCDT's Urologia e Broncologia	RCE	Urologia / Pneumologia	Mobilwave - Tecnologias de Informação, Lda.	506929183	Mobilwave - Tecnologias de Informação, Lda.	506929183	#N/D
Easyvista	URL	Easyvista	Gestão de serviços de IT	Integração	Apoio à Prestação de Cuidados	Easyvista, S.A.	501926003	Easyvista, S.A.	501926003	#N/D
EDIS	URL	Emergency Department Information System	Sistema de Informação de Emergência.	Urgência	Urgência	ALERT	507567455	ALERT	507567455	HL7
Ensemble	URL	Ensemble	Integração de aplicações	Integração	Apoio à Prestação de Cuidados	InterSystems Iberia, S.L.	B85286755	InterSystems Iberia, S.L.	B85286755	HL7 DICOM
GIAF	URL	GIAF	Software de gestão integrada	Gestão	Apoio à Prestação de Cuidados	Indra Sistemas Portugal, S.A	506176142	Indra Sistemas Portugal, S.A	506176142	#N/D
GID	URL	Gestão Integrada da Doença	Comunicação e acesso a relatórios de exames histológicos de biópsias LIS	Consulta	Todos	SPMS	509540716	#N/D	#N/D	#N/D
Glintt ANAPAT	URL	Glintt ANAPAT	Sistema de Laboratório e Anatomia Patológica	Laboratório (LIS) & Patologia Clínica	UGI de MCDT's	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt CARDIO	URL	Glintt CARDIO	-	Imagem (PACS)	Cardiologia	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D

Available SW at Hospital de Gaia. Acessed in May 2021. Available at: http://aprendis.gim.med.up.pt/index.php/Centro_Hospitalar_de_Vila_Nova_de_Gaia/Espinho

List of available IS

(page 2)

Glintt eResults	URL	Glintt eResults	Disponibilização de resultados de MCDT's	Imagem (PACS)	Apoio à Prestação de Cuidados	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt HIPO	URL	Glintt HIPO	Tratamento de hipocoagulados	Serviço de Sangue e Imunohemoterapia	UGI de MCDT's	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt NEURO	URL	Glintt NEURO	Pedidos de MCDT	Imagem (RIS)	Neurologia / Neurocirurgia	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt PNEUMO	URL	Glintt PNEUMO	Pedidos de MCDT	Imagem (RIS)	Pneumologia	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt RADIO	URL	Glintt RADIO	Agrega permite o acesso aos resultados dos exames de imagem	Imagem (RIS)	Radiologia	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt SGICMF	URL	Sistema de Gestão Integrado do Circuito do Medicamento - Farmácia	Sistema de Gestão Integrado do Circuito do Medicamento - farmácia	Farmácia	Serviço Farmacêutico	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt SGICML	URL	Sistema de Gestão Integrado do Circuito do Medicamento - Logística	Sistema de Gestão Integrado do Circuito do Medicamento - logística	Logística	Serviço Farmacêutico	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt SIBAS	URL	Glintt SIBAS	Sistema de Banco de Sangue	Laboratório (LIS)	UGI de MCDT's	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
Glintt SISLAB	URL	Glintt SISLAB	Sistema de Laboratório	Laboratório (LIS)	UGI de MCDT's	Glintt - Healthcare Solutions, S. A	502479418	Glintt - Healthcare Solutions, S. A	502479418	#N/D
HEPiC	URL	Hospital EPIdemiologic Control	Vigilância epidemiológica em unidades de saúde	Gestão > Indicadores	Apoio à Prestação de Cuidados	First-Global	505345978	First-Global	505345978	HL7
IDS7	URL	IDS7	PACS da Imagiologia	Imagem (PACS)	Apoio à Prestação de Cuidados	Sectra Medical Systems S.L.	980379920	ARTCES - Unipessoal, Lda	513270396	DICOM
ObsCare	URL	Virtual Care ObsCare	Suporte à prática ginecológica e obstétrica.	RCE	Ginecologia & Obstetrícia	VirtualCare, Lda	510394639	VirtualCare, Lda	510394639	openEHR
PDS	URL	Plataforma de Dados da Saúde	Registo e partilha de informação clínica de acordo com os requisitos da Comissão Nacional de Proteção de Dados.	Logística	Apoio à GEstão	SPMS	509540716	#N/D	#N/D	HL7
PEM	URL	Prescriçao Electronica Médica de Medicamentos e Cuidados Respiratorios Domiciliários	Prescrição eletrónica de medicamentos, cuidados respiratórios domiciliários e de meios complementares de diagnóstico	Farmácia / Prescrição	Serviço Farmacêutico	SPMS	509540716	#N/D	#N/D	HL7

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List of available IS

(page 3)

PICIS	URL	PICIS	Sincronização de dados entre dispositivos de bloco operartório; fluxo de informação do paciente.	Cirurgia	UGI de Cirurgia	Cerner Portugal	513269843	Cerner Portugal	513269843	#N/D
RHV	URL	Recursos Humanos e Vencimentos	Processamento de remunerações e gestão de recursos humanos	Financeiro & RH	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
RISI	URL	RISI	Gestão de risco, entidades, horários, qualidade, auditorias, comercial.	Gestão	Apoio à Prestação de Cuidados	Risi - Gestão e Administração Lda.	503 397 660	Risi - Gestão e Administração Lda.	503 397 660	#N/D
RNCCI	URL	Plataforma Rede Nacional de Cuidados Continuados Integrados - PNCCI	Plataforma Rede Nacional de Cuidados Continuados Integrados	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SAGMD	URL	Sistema de Apoio à Gestão de Mobilidade de Doenças	Reembolso de Despesas com Assistência Médica no Estrangeira	ADT	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SAPA	URL	Sistema de Atribuição de Produtos de Apoio	Sistema de Atribuição de Produtos de Apoio	Logística	Apoio à Gestão	SPMS	509540716	#N/D	#N/D	HL7
SClínico Hospitalar	URL	SClínico Hospitalar	Acesso e registo de informação no Electronic Health Record do paciente, em consulta e internamento, por médicos e enfermeiros.	RCE	Todos	SPMS	509540716	#N/D	#N/D	HL7
SGES	URL	Sistema de Gestao das Entidades da Saude	Identificação e caraterização das entidades prestadoras de cuidados de saúde - Módulo Instalaçoes.	Logística	Apoio à Gestão	SPMS	509540716	#N/D	#N/D	HL7
SICA	URL	Sistema de Informação de Contratualização e Acompanhamento	Suporte ao processo de planeamento estratégico, contratualização e monitorização do desempenho (eficiência e efectividade) da prestação de serviços"	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SICC	URL	Sistema de informação centralizado de contabilidade	Recolha de informação contabilística e o reporting de informação	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SICO	URL	Sistema de Informação de Certificados de Obito Certificação	Certificação desmaterializada de óbitos. Permite o tratamento estatístico das causas de morte	ADT	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SICTH	URL	Sistema de Informação da Consulta a Tempo e Horas	CTH – Consulta a Tempo e Horas - Sistema integrado de referenciação e gestão do acesso à primeira consulta de especialidade hospitalar.	Consulta	Todos	SPMS	509540716	#N/D	#N/D	HL7

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List of available IS

(page 4)

SIGLIC / SIGIC	URL	Sistema Integrado de Gestão de Inscritos para Cirurgia	Informação sobre a lista de inscritos para cirurgia no Serviço Nacional de Saúde, dados estatísticos e de indicadores para controlo de gestão da atividade cirúrgica programada.	Cirurgia	Apoio Técnico / UGI de Cirurgia	SPMS	509540716	#N/D	#N/D	HL7
SiiMA Gastroenterologia	URL	SiiMA Gastroenterologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Gastroenterologia, desde a admissão do utente até à emissão do relatório médico	Consulta	Gastroenterologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SiiMA Oftalmologia	URL	SiiMA Oftalmologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Oftalmologia, desde a admissão do utente até à emissão do relatório médico.	Consulta	Oftalmologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SIMH	URL	Sistema de Informação para a Morbilidade Hospitalar	Sistema de Informação para a Morbilidade Hospitalar Codificação de episódios, de internamento e ambulatório, em ICD 10 CM/PCS e agrupamento em GDH para fins de tratamento estatístico e facturação.	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SINAVE	URL	Sistema Nacional de Apoio à Vigilancia Epidemiologica	Sistema de vigilância em saúde pública: identificação de situações de risco, recolha, análise e divulgação de dados relativos a doenças transmissíveis e outros riscos em saúde pública.	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SITAM	URL	Sistema de Informaçao para Pagamento de Taxas Moderadoras em Atraso	Serviço centralizado que assegura todo o processo de alerta, notificação e cobrança das taxas moderadoras	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SIVIDA	URL	Sistema de Informaçao dos paciente com VIH	Ferramenta de suporte à monitorização do Programa de Controlo do HIV/SIDA: registo de atividade de prestação de cuidados e produção de reports ad hoc.	Consulta	Apoio Técnico	SPMS	509540716	#N/D	#N/D	HL7
SONHO v1	URL	Sistema Integrado de Informação Hospitalar	Sistema de informação dos hospitais; Apoio ao processo administrativo e financeiro hospitalar	ADT	Todos	SPMS	509540716	#N/D	#N/D	#N/D
Sorian Scheduling	URL	Sorian Scheduling	Gestão e agendamento de cuidados de saúde hospitalares.	ADT & Logística	Apoio à Prestação de Cuidados	Cerner Portugal	513269843	Cerner Portugal	513269843	FHIR HL7

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List of available IS

- Many IS exist in hospitals (~ 50)

(page 5)

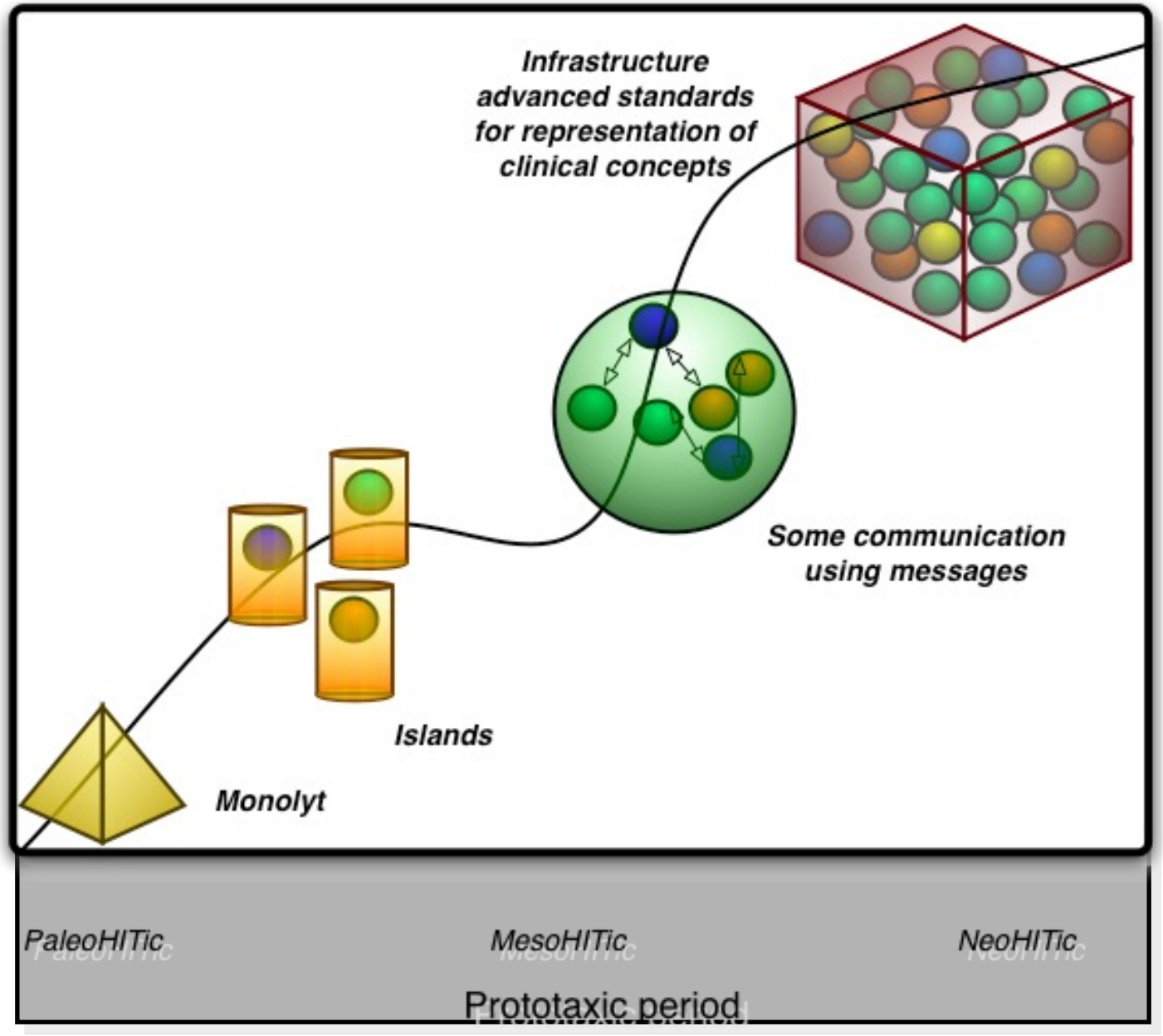
SIGLIC / SIGIC	URL	Sistema Integrado de Gestão de Inscritos para Cirurgia	Nacional de Saúde, dados estatísticos e de indicadores para controlo de gestão da atividade cirúrgica programada.	Cirurgia	Apoio Técnico / UGI de Cirurgia	SPMS	509540716	#N/D	#N/D	HL7
SiiMA Gastroenterologia	URL	SiiMA Gastroenterologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Gastroenterologia, desde a admissão do utente até à emissão do relatório médico	Consulta	Gastroenterologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SiiMA Oftalmologia	URL	SiiMA Oftalmologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Oftalmologia, desde a admissão do utente até à emissão do relatório médico.	Consulta	Oftalmologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SIMH	URL	Sistema de Informação para a Morbilidade Hospitalar	Sistema de Informação para a Morbilidade Hospitalar Codificação de episódios, de internamento e ambulatório, em ICD 10 CM/PCS e agrupamento em GDH para fins de tratamento estatístico e facturação.	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SINAVE	URL	Sistema Nacional de Apoio à Vigilancia Epidemiologica	Sistema de vigilância em saúde pública: identificação de situações de risco, recolha, análise e divulgação de dados relativos a doenças transmissíveis e outros riscos em saúde pública.	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SITAM	URL	Sistema de Informaçao para Pagamento de Taxas Moderadoras em Atraso	Serviço centralizado que assegura todo o processo de alerta, notificação e cobrança das taxas moderadoras	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SIVIDA	URL	Sistema de Informaçao dos paciente com VIH	Ferramenta de suporte à monitorização do Programa de Controlo do HIV/SIDA: registo de atividade de prestação de cuidados e produção de reports ad hoc.	Consulta	Apoio Técnico	SPMS	509540716	#N/D	#N/D	HL7
SONHO v1	URL	Sistema Integrado de Informação Hospitalar	Sistema de informação dos hospitais; Apoio ao processo administrativo e financeiro hospitalar	ADT	Todos	SPMS	509540716	#N/D	#N/D	#N/D
Sorian Scheduling	URL	Sorian Scheduling	Gestão e agendamento de cuidados de saúde hospitalares.	ADT & Logística	Apoio à Prestação de Cuidados	Cerner Portugal	513269843	Cerner Portugal	513269843	FHIR HL7
syngo Dynamics	URL	syngo Dynamics	Sistema de transferência, armazenamento, arquivo e manipulação de imagens digitais, revisão, análise, quantificação e relatórios em cardiologia.	Imagem (PACS)	Cardiologia	Siemens Health Care Diagnostics, Lda,	507925173	Siemens Health Care Diagnostics, Lda,	507925173	DICOM

Available SW at Hospital de Gaia. Acessed in May 2021. Available at: http://aprendis.gim.med.up.pt/index.php/Centro_Hospitalar_de_Vila_Nova_de_Gaia/Espinho

Question

- Can interoperability in health expected to be simple?

Interoperability evolution and expectations



Mori, A. R., & Freriks, G. (2005). A European Perspective on the Cultural and Political Context for Deploying the Electronic Health Record. In *Person-Centered Health Records* (pp. 201–220). Springer New York. https://doi.org/10.1007/0-387-27375-1_14

Interoperability definition (expectations)

interoperability (def): the level of interoperability between distinct components of an information processing environment (applications, services, systems etc) is proportional to their ability to

correctly communicate their ***internal semantics*** to each other,

without special measures,

other than **syntax** or **technology** adaptation.

Thomas Beale 2021. https://wolandscat.net/2021/04/17/what-is-interoperability

Interoperability levels & Specialists needed

Interoperability levels

- **Foundational (Level 1):** Establishes the inter-connectivity requirements needed for one system or application to **securely communicate** data to and receive data from another
- **Structural (Level 2):** Defines the **format**, **syntax** and **organization** of data exchange including at the **data field level for interpretation**
- **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
- **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

https://www.himss.org/resources/interoperability-healthcare

Level 1 - Foundational

- Issues
  - Legacy systems using proprietary formats or non-appropriate communication methods (eg. direct database links)
- Specialists
  - IT personal and Software Developers
  - Health Informaticians is not critical for this level

Level 2 - Structural

- Issues
  - Many systems still **do not use** HL7 v2 or HL7 FHIR, or use it in a non-standardized manner
  - New comers prefer to create protocols based on REST or SOAP, to use existing standards

- Specialists
  - Health Informaticians are **critical** for this level in particular with experience in integrations

Level 3 - Semantic

- Issues
  - Many different terminologies
  - Evolution of terminologies (version control) and terminology mappings
  - Lack of consistent use of terms and concepts

- Specialists
  - Health professionals – in particular in **clinical coding**
  - Health Informatics professionals – in particular in **health ontologies**

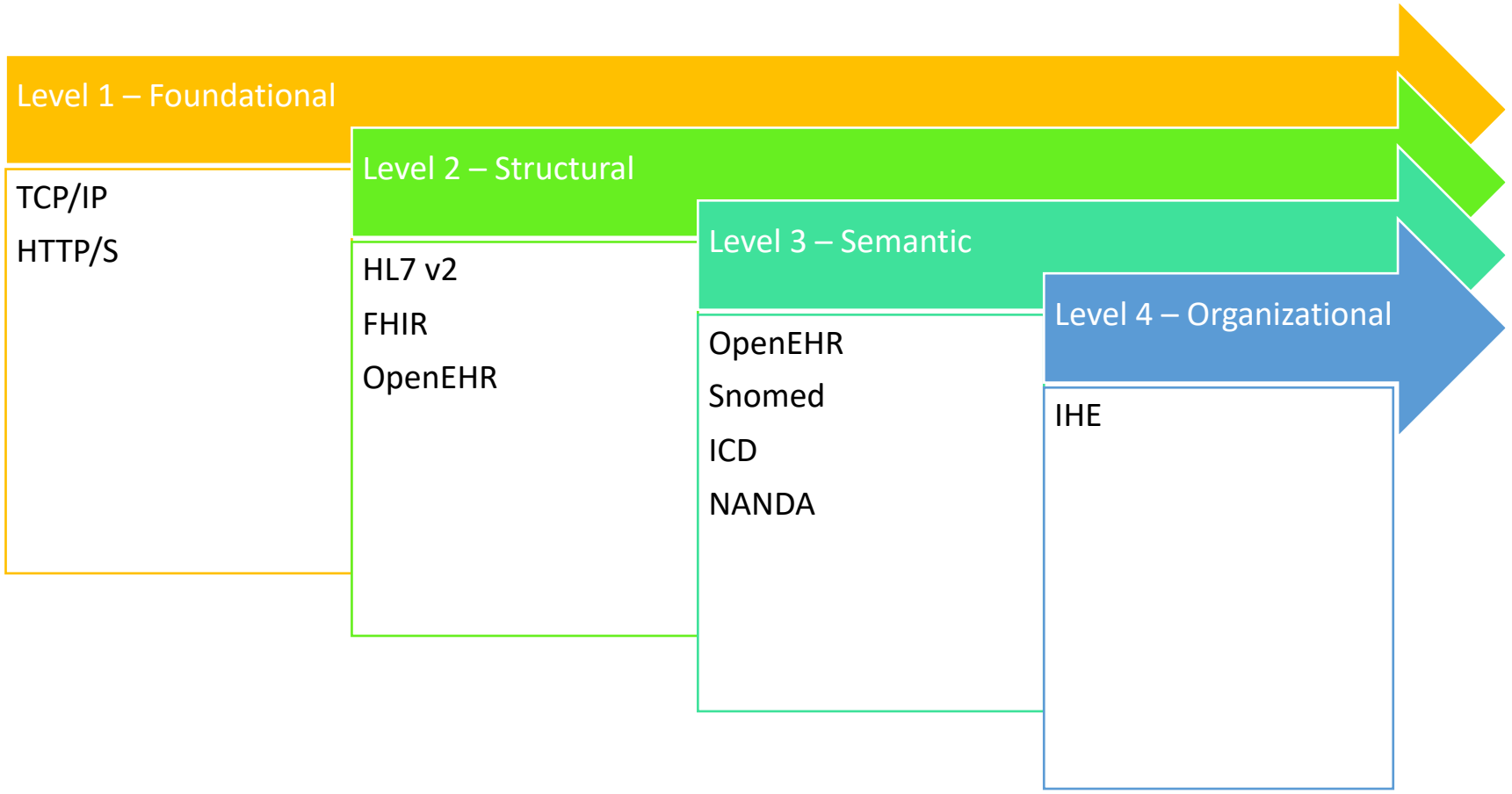
Level 4 - Organizational

- Issues
  - Security and trust
  - Cross-border workflows

- Specialists
  - Legal experts
  - Health institution managers
  - Public Health
  - Experts working of patient pathways

Existing standards

Interoperability levels and existing standards



Integrating the Healthcare enterprise

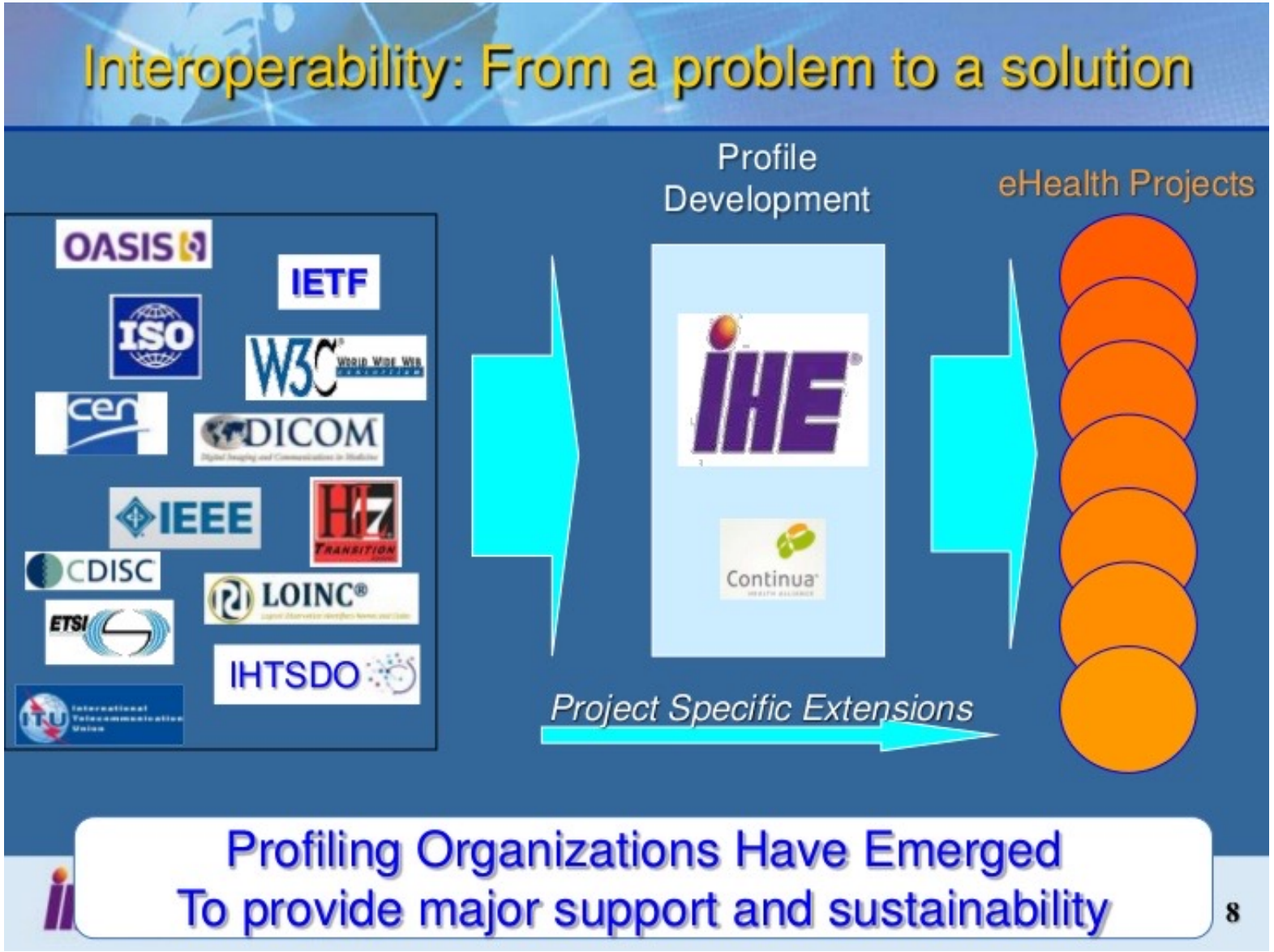
What is IHE

IHE is na initiative by **healthcare** professionals and **industry**

to **improve** the way computer systems in healthcare **share** information.

Promotes the coordinated use of established standards such as **DICOM** and **HL7** to address specific clinical needs in support of optimal patient care.

Systems developed in accordance with IHE **communicate with one another better**, are **easier to implement**, and enable care providers to **use information more effectively**


Interoperability: From a problem to a solution
Profile Development
eHealth Projects
OASIS
IETF
ISO
W3C
cen
DICOM
IEEE
HL7
CDISC
LOINC
ETSI
IHTSDO
ITU
IHE
Continua
Project Specific Extensions
Profiling Organizations Have Emerged
To provide major support and sustainability
8

ANNEX

LIST OF 'INTEGRATING THE HEALTHCARE ENTERPRISE' PROFILES ELIGIBLE FOR REFERENCING IN PUBLIC PROCUREMENT

1. IHE XCPD: Cross-Community Patient Discovery;
2. IHE XCA: Cross-Community Access;
3. IHE XCF: Cross-Community Fetch;
4. IHE XDR: Cross-Enterprise Document Reliable Interchange;
5. IHE CT: Consistent Time;
6. IHE ATNA: Audit Trail and Node Authentication;
7. IHE BPPC: Basic Patient Privacy Consents;
8. IHE XUA: Cross-Enterprise User Assertion;
9. IHE PRE: Pharmacy Prescription;
10. IHE DIS: Pharmacy Dispense;
11. IHE XPHR: Exchange of Personal Health Record Content;
12. IHE XD-MS: Cross-Enterprise Sharing of Medical Summaries Integration Profile;
13. IHE XD-SD: Cross-Enterprise Sharing of Scanned Documents;

LIST OF 'INTEGRATING THE HEALTHCARE ENTERPRISE' PROFILES ELIGIBLE FOR REFERENCING IN PUBLIC PROCUREMENT, (2015) (testimony of European Commission).

14. IHE PIX: Patient Identifier Cross-Referencing;
15. IHE PDQ: Patient Demographics Query;
16. IHE XDS.b: Cross-Enterprise Document Sharing;
17. IHE XDS-I.b: Cross-Enterprise Document Sharing for Imaging;
18. IHE XD-LAB: Laboratory Reports;
19. IHE XDM: Cross-Enterprise Document Media Interchange;
20. IHE SVS: Sharing Value Sets;
21. IHE SWF: Radiology Scheduled Workflow;
22. IHE SWF.b: Radiology Scheduled Workflow;
23. IHE PIR: Patient Information Reconciliation;
24. IHE PAM: Patient Administration Management;
25. IHE LTW: Laboratory Testing Workflow;
26. IHE LCSD: Laboratory Code Sets Distribution;
27. IHE LWA: Laboratory Analytical Workflow.

LIST OF 'INTEGRATING THE HEALTHCARE ENTERPRISE' PROFILES ELIGIBLE FOR REFERENCING IN PUBLIC PROCUREMENT, (2015) (testimony of European Commission).

IHE LTW – Laboratory Testing Workflow

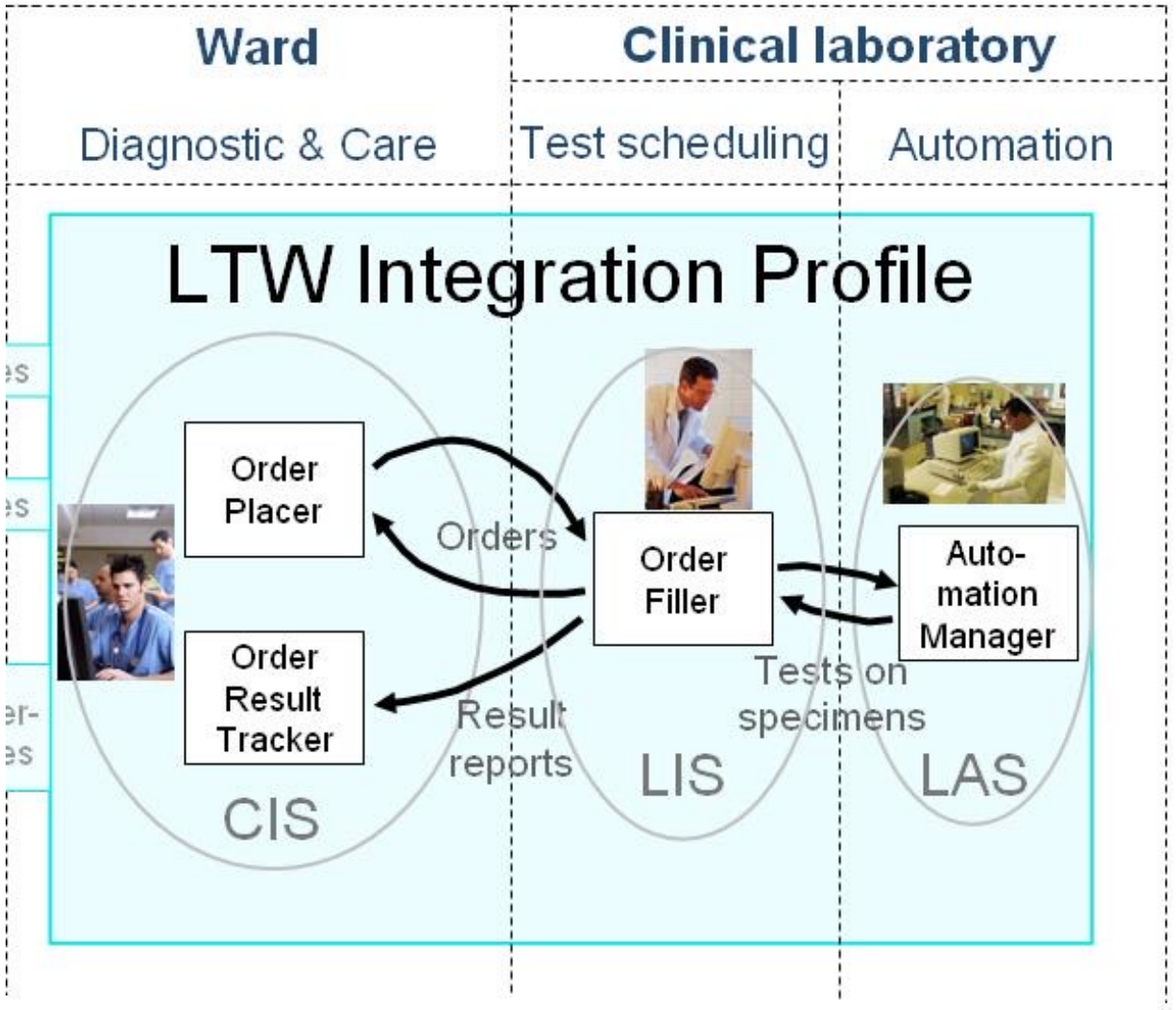
Actors:

- Order Placer
- Order Filler
- Automation Manager
- Order Result Tracker

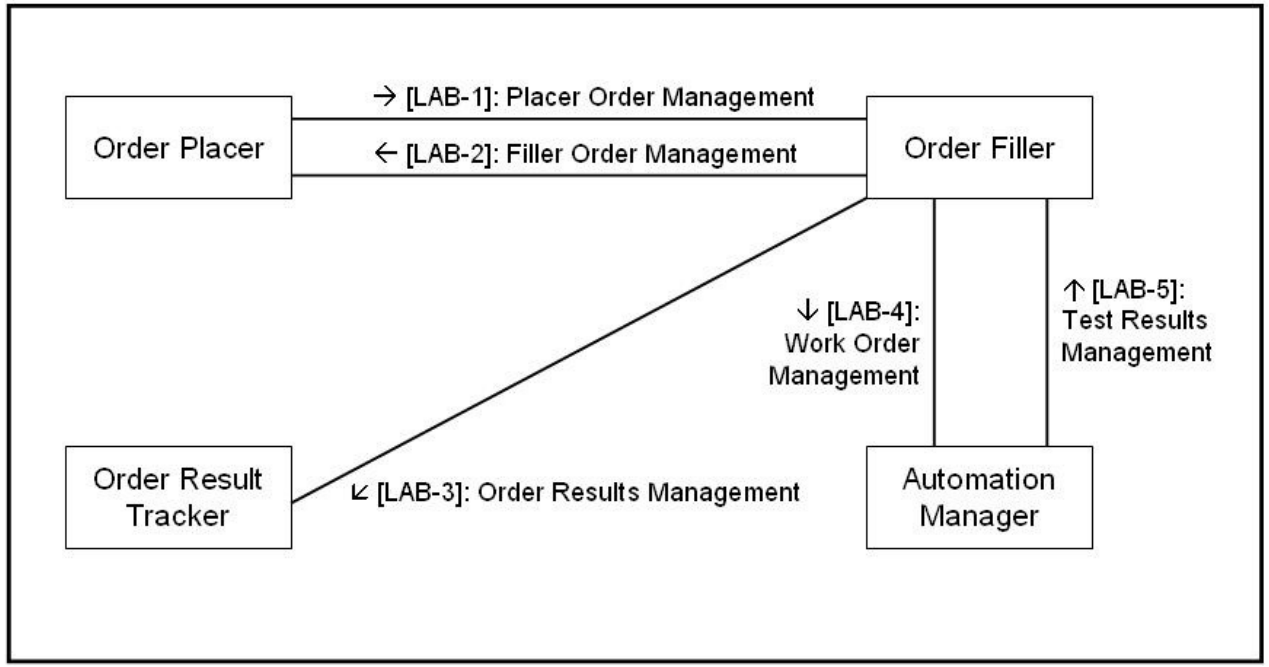
CIS – Clinical Information System

LIS – Lab Information System

LAS – Lab Automation System



IHE LTW - Actors and transactions



LAB-1 – Placer Order Management

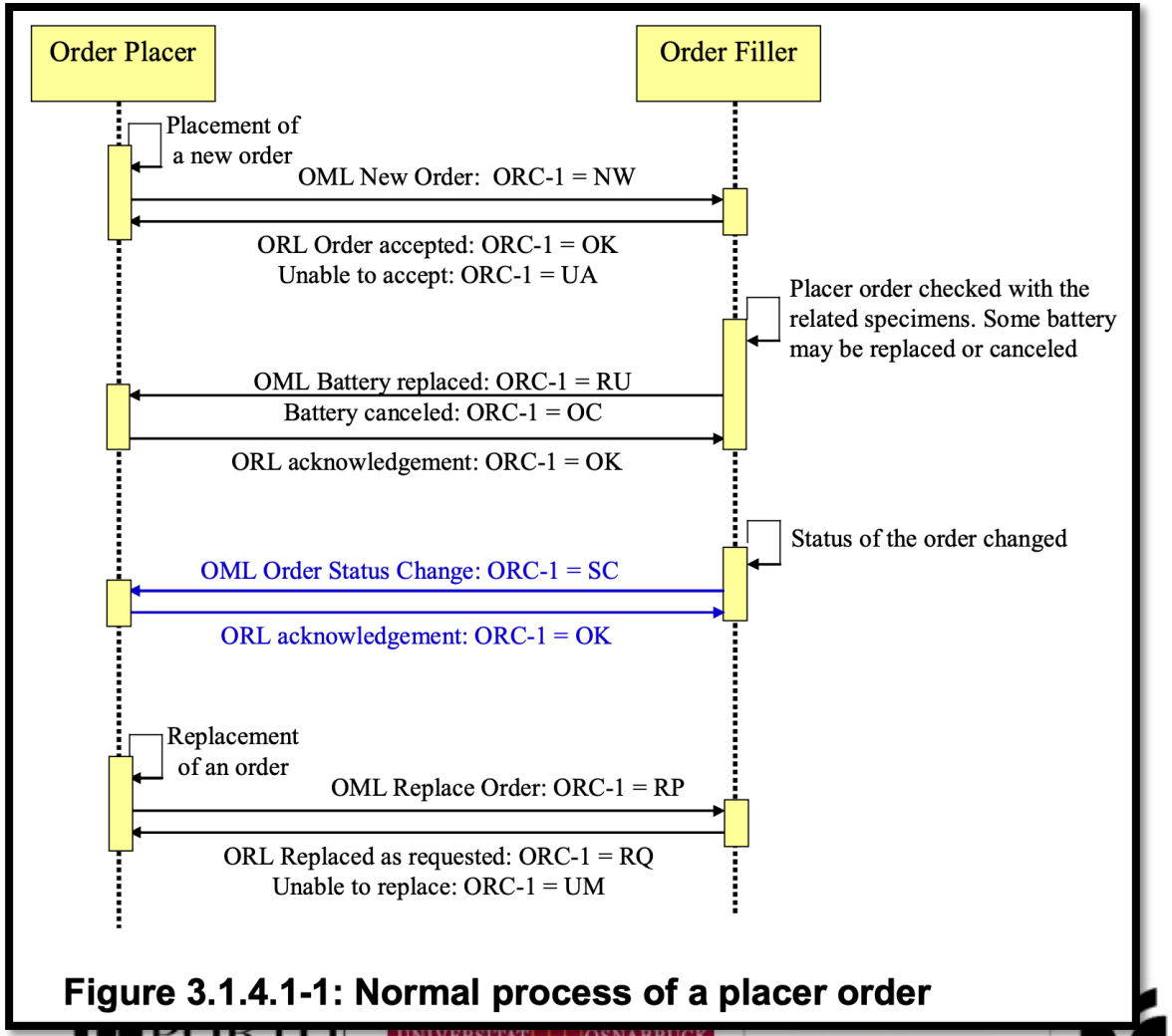


Figure 3.1.4.1-1: Normal process of a placer order

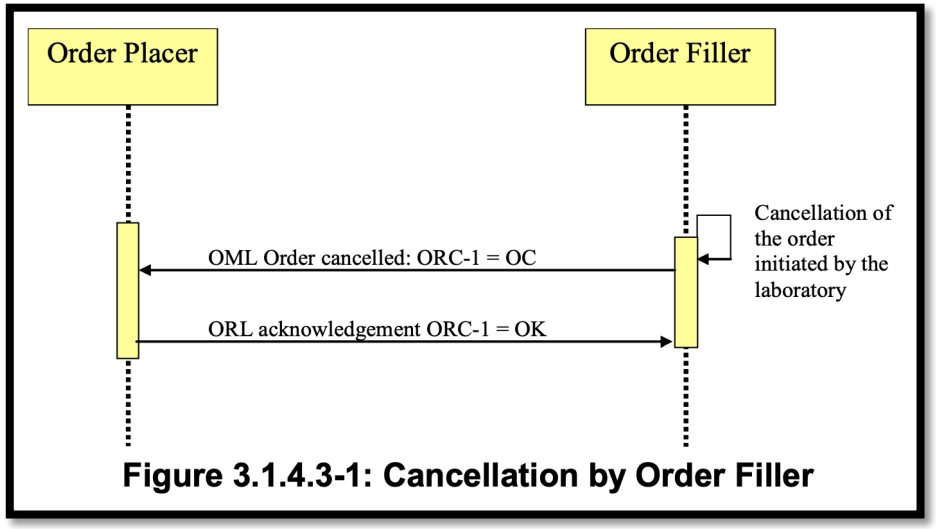
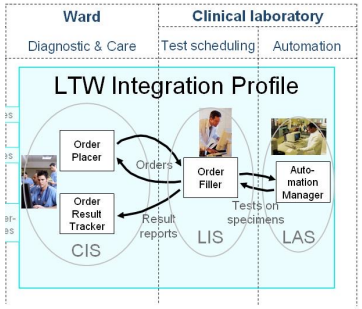


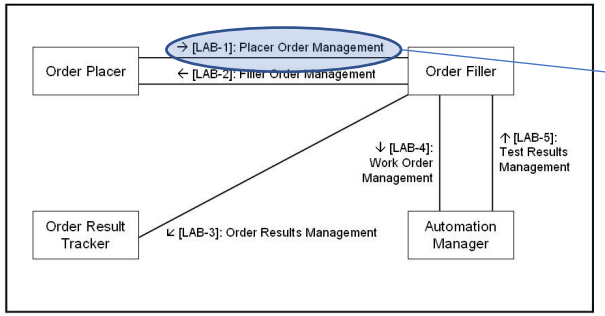
Figure 3.1.4.3-1: Cancellation by Order Filler

HL7 OML example

```
MSH|^~\&|HL7_DEFAULT|INST|HOS|INST|20190823093000||OML^O21^OML_O21|4ab9e6b5-7372-123456789|D|2.5||||AL||8859/1||
PID|1||111181^^^HOS^NS~123456789^^^HAS^SNS~123456789^^^HAS^SNS~123422222^^^AT^NIF||LAST_NAME^FIRST_NAME^MIDDLE_NAME^^^^L||1
9910820000000|F|||||^PRN^CP^^^^^^^^^961899950~^NET^X.400^lastname@gmail.com|||S||99205842^^^HOS||
CON|1||||||||||A||20190520||
PV1|1|INT|3^||||||||||20|||||14000592^^^HOS|||||||||||||||||||||20190823090035|||||||V||
IN1|1|990004^Num benefeciario da entidade
X^HOS|12345^|DescricaoNomeOrganizacao||||||||20190101|20191231||EHCPOL|LAST_NAMETeste^FIRST_NAMETeste^MIDDLE_NAME^^^^L||199108200000
00|||||||||||||||||RECM|
ORC|NW|19911^HL7_DEFAULT|12345^HOS|GRP007|||||20190820163000|1845^Testes - 31^Utilizador de^^^^^^HOS~2031^Testes - 31^Utilizador
de^^^^^^N.Mecanogr\XE1\fico||1845^Testes - 31^Utilizador de^^^^^^HOS~2031^Testes - 31^Utilizador de^^^^^^N.Mecanogr\XE1\fico||||TaskReason:
Mensagem Exemplo|3147202^HOSPITAL DISTRITAL||9009^Utilizador^Teste^^^^^^N.ORDEM|1^Service is subject to medical necessity
procedures^HL70339|||||||20190830||||
TQ1|1||||||20190823133000|20190823143000|A^ASAP^HL70485|
OBR|1|19911^HL7_DEFAULT|12345^HOS|O70251^RETINOGRAFIA^LOINC^103693007^Diagnostic
procedure^LOINC|||20190823130020|||2300^Observador^Exemplo^^^^^^HOS|||Informacao clinica/Observacoes de Realizacao|||||||||||||||||||||||||||||R||
SPM|1|ID_Amostra_12345||119339001^Stool Specimen^SNOMED|||123132^Método colheita
Exemplo^SystemXPTO^NEUT^Neutralization^|344001^Ankle^SNOMED|||||||||20190826100115|20190826161520||Y|||||5^Mg|
```

IHE Profiles ➔ HL7 Messages





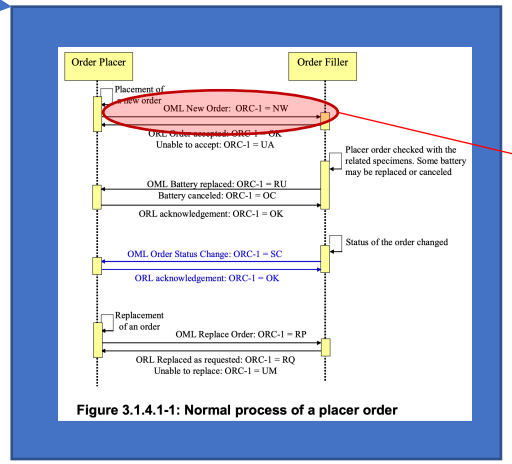
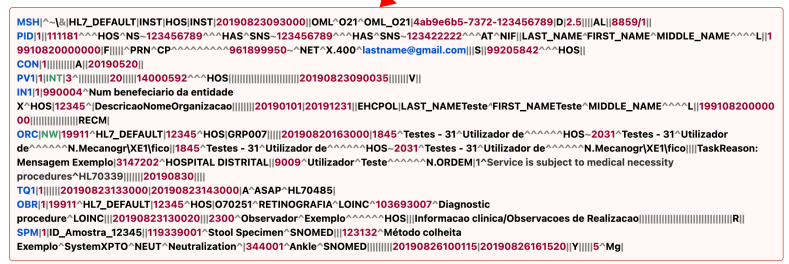


Figure 3.1.4.1-1: Normal process of a placer order

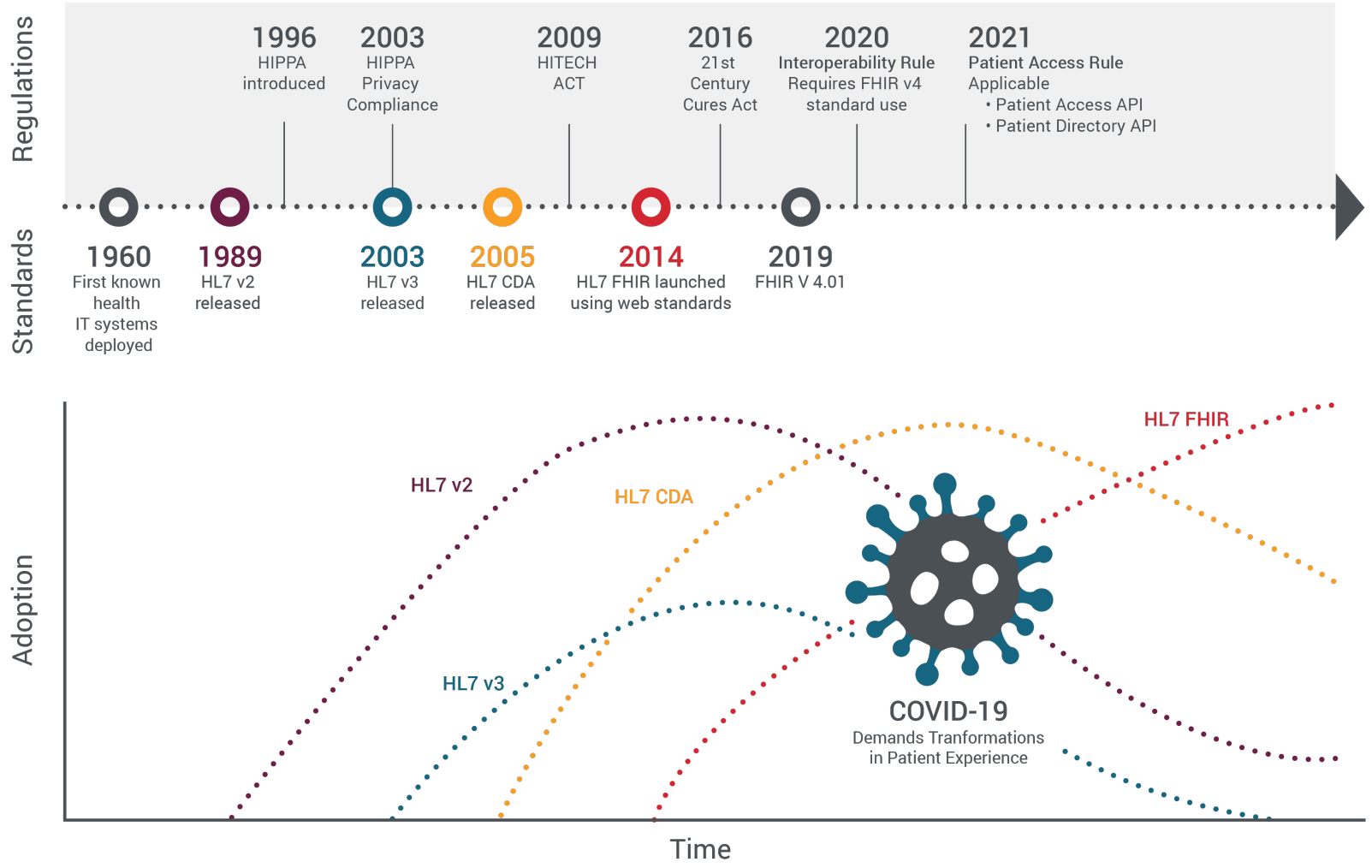


Actors Transactions Processes HL7 Messages

HL7

Mainly v2

HL7 evolution



HL7 Message Types

ACK – General acknowledgement

ADT – Admit, Discharge, Transfer

BAR – Add/change billing account

DFT – Detailed financial transaction

MDM – Medical document management

MFN – Master files notification

ORM – Order (Pharmacy/treatment)

ORU – Observation result (unsolicited)

QRY – Query, original mode

RAS – Pharmacy/treatment administration

RDE – Pharmacy/treatment encoded order

RGV – Pharmacy/treatment give

SIU – Scheduling information unsolicited

ADT ^ A01 – Admit/visit

ADT ^ A02 – patient transfer

ADT ^ A03 – patient discharge

ADT ^ A04 – patient registration

ADT ^ A05 – patient pre-admission

ADT ^ A08 – patient information update

ADT ^ A11 – cancel patient admit

ADT ^ A12 – cancel patient transfer

ADT ^ A13 – cancel patient discharge

HL7 ADT^A01 – Admit/visit notification

MSH|^~\&|SONHO|HSJ|RIS|HSJ|20080810090131||ADT^A01|SONHO01052901|P|2.4

EVN|A01|20080710090000||01||20080710090000

PID|||56782445^^^SNS^PT~999855750^^^HSJ^PI||Apelido^Primeiro Nome^Oliveira^SR||19620910|M||C|AVENIDA DO EXEMPLO N389 1oDto^^Porto^^4200-526^Portugal^H|PT|224 231 123|||||0105I30001

PV1||I|W^389^1^UABH^^^^3||||12345^MEDICO^SENHOR^J^^^MD^^^UAMC^L||67890^MEDICO^CONSULTA^X^^^MD^^^UAMC^L|MED|||||A0||13579^MEDICO^ADMISSAO^T^ ^^MD^^^UAMC^L ||INT1234^^^SONHO^FI^HSJ^20080709

OBX|1|NM|HT^HEIGHT^99LOC1||71|in^inches^ANSI+|||||F

OBX|2|NM|WT^WEIGHT^99LOC1||175|lb^pounds^ANSI+|||||F

AL1|1|DA|ASP^ASPIRIN^99LOC2|MO|GI DISTRESS

An ADT^A01 event is intended to be used for “Admitted” patients only. An A01 event is sent as a result of a patient undergoing the admission process which assigns the patient to a bed. It signals the beginning of a patient’s stay in a healthcare facility.exemplo

HL7 ADT^A01 – Admit/visit notification

MSH|^~\&|SONHO|HSJ|RIS|HSJ|200808100901311||ADT^A01|SONHO01052901|P|2.4

EVN|A01|20080710090000||01||20080710090000

PID|||56782445^^^SNS^PT~999855750^^^HSJ^PI||Apelido^Primeiro Nome^Oliveira^SR||19620910|M||C|AVENIDA DO EXEMPLO N389 1oDto^^Porto^^4200-526^Portugal^H|PT|224 231 123|||||0105I30001

PV1||I|W^389^1^UABH^^^^3||||12345^MEDICO^SENHOR^J^^^MD^^^UAMC^L||67890^MEDICO^CONSULTA^X^^^MD^^^UAMC^L|MED|||||A0||13579^MEDICO^ADMISSAO^T^ ^^MD^^^UAMC^L ||INT1234^^^SONHO^FI^HSJ^20080709

OBX|1|NM|HT^HEIGHT^99LOC1||71|in^inches^ANSI+|||||F

OBX|2|NM|WT^WEIGHT^99LOC1||175|lb^pounds^ANSI+|||||F

AL1|1|DA|ASP^ASPIRIN^99LOC2|MO|GI DISTRESS

An ADT^A01 event is intended to be used for “Admitted” patients only. An A01 event is sent as a result of a patient undergoing the admission process which assigns the patient to a bed. It signals the beginning of a patient’s stay in a healthcare facility.exemplo

HL7 ADT^A01 – Admit/visit notification

MSH|^~\&|SONHO|HSJ|RIS|HSJ|20080810090131||ADT^A01|SONHO01052901|P|2.4

EVN|A01|20080710090000||01||20080710090000

PID|||56782445^^^SNS^PT~999855750^^^HSJ^PI||Apelido^Primeiro Nome^Oliveira^SR||19620910|M||C|AVENIDA DO EXEMPLO N389 1oDto^^Porto^^4200-526^Portugal^H|PT|224 231 123|||||0105I30001

PV1||I|W^389^1^UABH^^^^3||||12345^MEDICO^SENHOR^J^^^MD^^^UAMC^L||67890^MEDICO^CONSULTA^X^^^MD^^^UAMC^L|MED|||||A0||13579^MEDICO^ADMISSAO^T^ ^^MD^^^UAMC^L ||INT1234^^^SONHO^FI^HSJ^20080709

OBX|1|NM|HT^HEIGHT^99LOC1||71|in^inches^ANSI+|||||F

OBX|2|NM|WT^WEIGHT^99LOC1||175|lb^pounds^ANSI+|||||F

AL1|1|DA|ASP^ASPIRIN^99LOC2|MO|GI DISTRESS

There are 7 segments in this message

Each segment starts with a segmentID (eg. MSH, EVN, PID, PV1, OBX, AL1)

HL7 ADT^A01 – Admit/visit notification

MSH|^~\&|SONHO|HSJ|RIS|HSJ|20080810090131||ADT^A01|SONHO01052901|P|2.4

EVN|A01|20080710090000||01||20080710090000

PID|||**56782445^^^SNS^PT**~999855750^^^HSJ^PI||Apelido^Primeiro Nome^Oliveira^SR||19620910|M||C|**AVENIDA DO EXEMPLO N389 1oDto^^Porto^^4200-526^Portugal^H**|PT|224 231 123|||||0105I30001

PV1||I|W^389^1^UABH^^^^3||||12345^MEDICO^SENHOR^J^^^MD^^^UAMC^L||67890^MEDICO^CONSULTA^X^^^MD^^^UAMC^L|MED|||A0||13579^MEDICO^ADMISSAO^T^ ^^MD^^^UAMC^L ||INT1234^^^SONHO^FI^HSJ^20080709

OBX|1|NM|HT^HEIGHT^99LOC1||71|in^inches^ANSI+|||||F

OBX|2|NM|WT^WEIGHT^99LOC1||175|lb^pounds^ANSI+|||||F

AL1|1|DA|ASP^ASPIRIN^99LOC2|MO|GI DISTRESS

PID – Patient Identification

HL7 ADT^A01 – Admit/visit notification

MSH|^~\&|SONHO|HSJ|RIS|HSJ|20080810090131||ADT^A01|SONHO01052901|P|2.4

EVN|A01|20080710090000||01||20080710090000

PID|||56782445^^^SNS^PT~999855750^^^HSJ^PI||Apelido^Primeiro Nome^Oliveira^SR||19620910|M||C|AVENIDA DO EXEMPLO N389 1oDto^^Porto^^4200-526^Portugal^H|PT|224 231 123|||||0105I30001

PV1||I|W^389^1^UABH^^^^3||||12345^MEDICO^SENHOR^J^^^MD^^^UAMC^L||67890^MEDICO^CONSULTA^X^^^MD^^^UAMC^L|MED|||A0||13579^MEDICO^ADMISSAO^T^ ^^MD^^^UAMC^L ||INT1234^^^SONHO^FI^HSJ^20080709

OBX|1|NM|HT^**HEIGHT**^99LOC1||**71**|**in^inches^ANSI**+|||||F

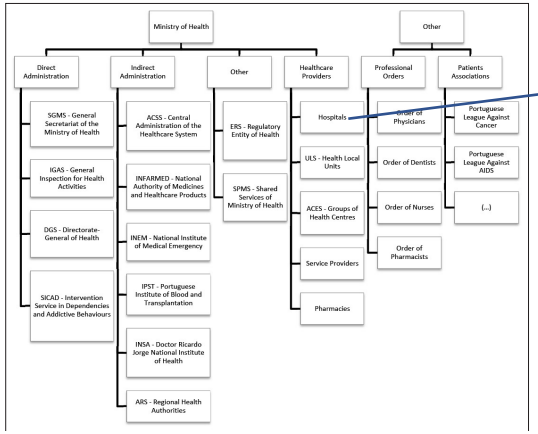
OBX|2|NM|WT^WEIGHT^99LOC1||175|lb^pounds^ANSI+|||||F

AL1|1|DA|ASP^ASPIRIN^99LOC2|MO|GI DISTRESS

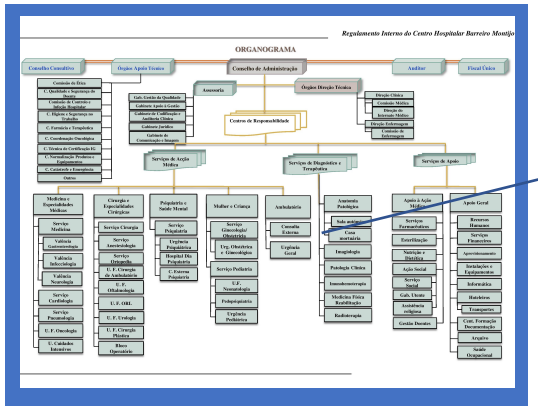
OBX – Observation

Big picture

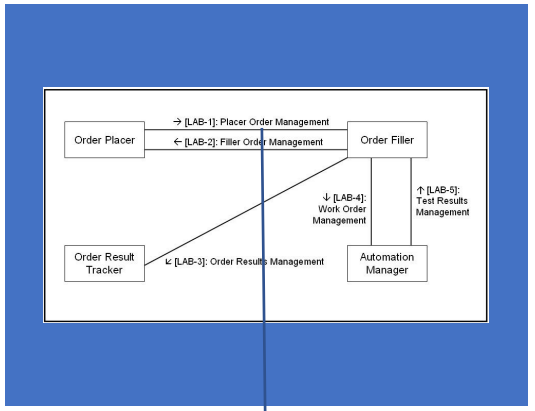
Interoperability in health complexity



Many institutions
~100

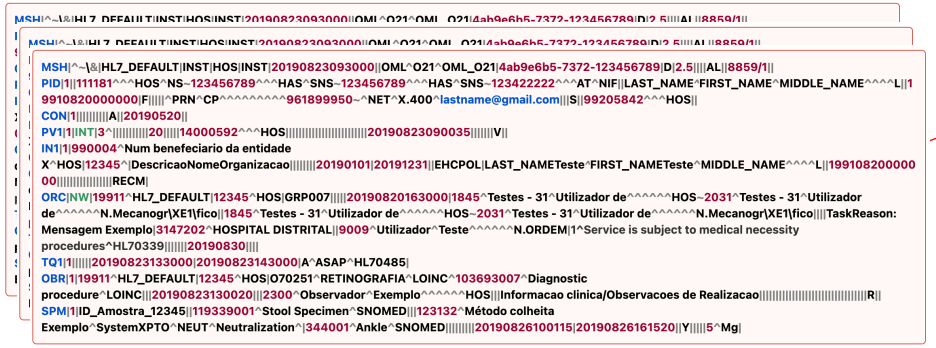


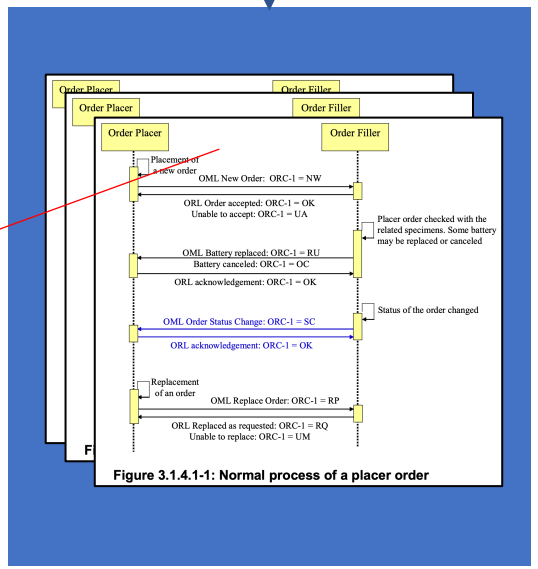
Many departments and IS
~50



Many Transactions

Many Message Types





Many Processes

Institutions

HL7 International

IHE

SNOMED

WHO ICD

CEN

EMA

OpenEHR

EFMI EUROPEAN FEDERATION for MEDICAL INFORMATICS

CTC.pt

IPQ

INFARMED

U.PORTO

UNIVERSITÄT OSNABRÜCK

HOCHSCHULE OSNABRÜCK

UNIVERSITY OF EASTERN FINLAND

Challenges and Opportunities

Challenges and opportunities

- The future is built of the back of data.
  With data coming at health systems from **every angle**,
  it is important for every healthcare organization to have a rock solid **understanding of the future of interoperability** and integration.

- The ability to exchange healthcare information between systems
  in a **timely** and **understandable** manner has always been important,
  and as the **volume** and **type** of health-related information **increases**,
  it is becoming even more important and **difficult** to achieve.

Healthcare IT Integration Market: Revenue in USD million, by Geography, Global, 2015-2024

Region	2015	2016	2017	2018	2024	CAGR (%)
North America	787.74	864.58	948.92	1,047.83	1,899.64	**10.42**
Europe	373.98	411.56	452.91	501.46	923.80	**10.72**
Asia-Pacific	323.00	356.74	393.99	437.80	824.07	**11.12**
Middle East & Africa	62.04	66.96	72.28	78.49	128.74	**8.60**
South America	88.05	96.00	104.63	114.68	197.08	**9.44**

Interoperability Drives

- GDPR – traceability
- EHDS – European Health Data Space
- Data Lakes – getting data from many sources
- Process Mining – understaning how an organization works
- Machine Learning – need for semantic models that are safe to get conclusions
- Home monitoring – interoperability between hospitals / primary care / homes
- Wearables – getting data from wearables into health records

Thanks

Ricardo João Cruz Correia

A gentle introduction to FHIR

João Almeida | joaofcalmeida@outlook.com

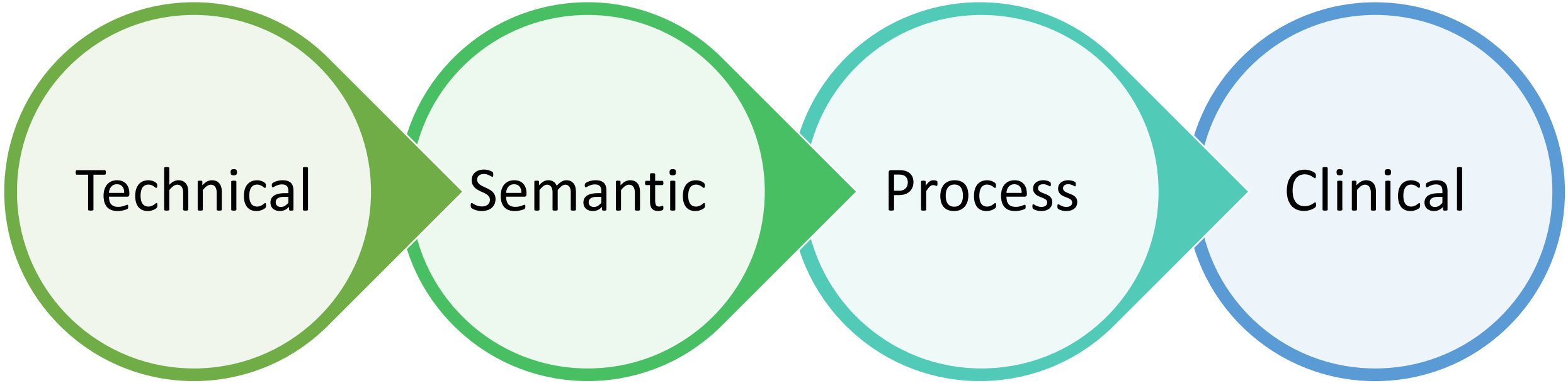
Summary

- Refresh Interoperability
- Brief notes on Previous Standards
- FHIR
- Special Uses
- CDS Hooks
- IHE

Interoperability

Data from A to B

Equal processes in A and B



Data means the same thing in A and B

Clinical streamflow

Standards

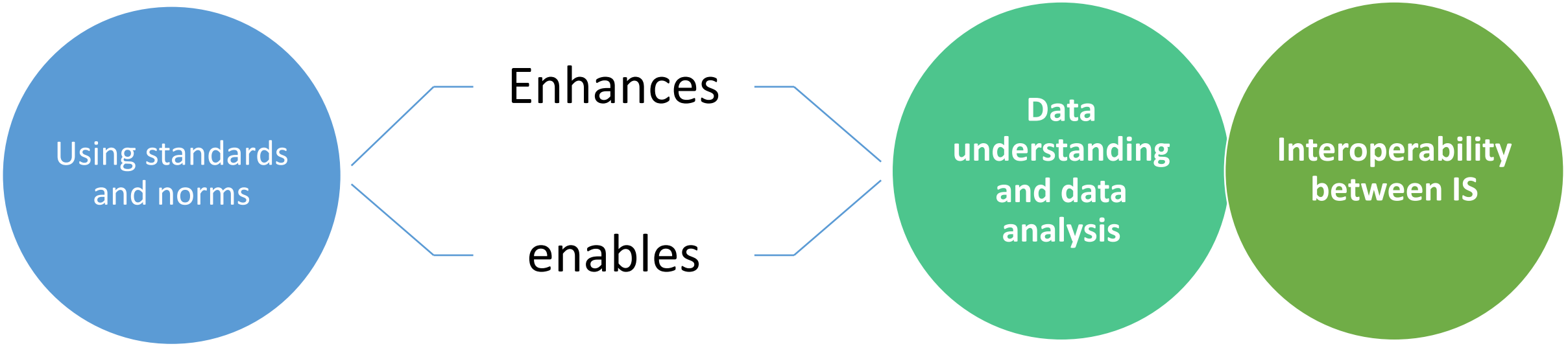
HL7 v2	HL7 v3	**HL7 FHIR**	ISO 13606
IEEE 1073	DICOM	ASC-X12	IHE
	Direct Standard™	PCHAlliance	

Standards

- Being compliant with a certain standard
- Supporting internationalization
- Being compatible with Solution Y, X or Z
- Data Normalization
- Reducing complexity without compromising diversity

Standards

Steamlined care



Codifying systems and standardized collection mechanisms

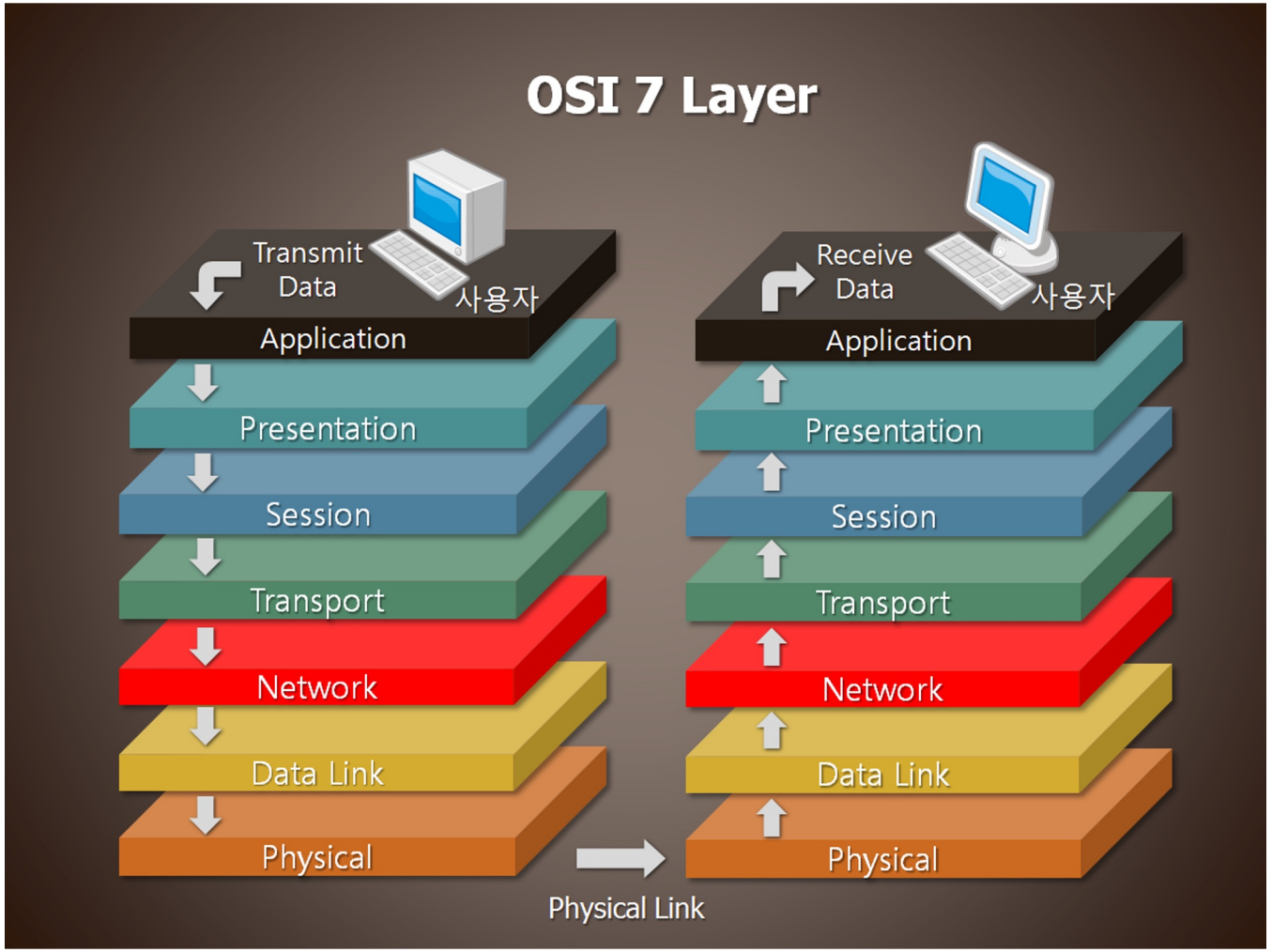
HL7 – the standard

HL7's Version 2.x (V2) messaging standard is the workhorse of electronic data exchange in the
clinical domain and arguably the most widely implemented standard for healthcare in the world.
This messaging standard allows the exchange of clinical data between systems.
It is designed to support a central patient care system as well as a more distributed environment
where data resides in departmental systems.

HL7 – the institution

- HL7 International is one of several American National Standards Institute (ANSI) accredited Standards Developing Organizations (SDOs) operating in the healthcare arena.
- HL7 International is a not-for-profit Standards Development Organization (SDO)
- HL7's members (providers, vendors, payers, consultants, government groups and others who have an interest in the development and advancement of clinical and administrative standards for healthcare) develop HL7's standards;

OSI Model


OSI 7 Layer
Transmit Data
사용자
Application
Presentation
Session
Transport
Network
Data Link
Physical
Receive Data
사용자
Application
Presentation
Session
Transport
Network
Data Link
Physical
Physical Link

HL7v2? HL7v3? RIM? FHIR? CDA?

What	When	Why
Version 2.x Messaging Standard	**1989**	**an interoperability specification for health and medical transactions**
Version 3 Messaging Standard	2005	an interoperability specification for health and medical transactions
Clinical Document Architecture (CDA)	2005	an exchange model for clinical documents, based on HL7 Version 3
The Reference Information Model (RIM)	2005	provides an explicit representation of the semantic and lexical connections that exist between the information carried in the fields of HL7 messages.
Fast Healthcare Interoperability Resources (FHIR)	**2011**	**draft standard from HL7 International designed to be easier to implement, more open and more extensible than version 2.x or 3. It leverages a modern web-based suite of API technology**

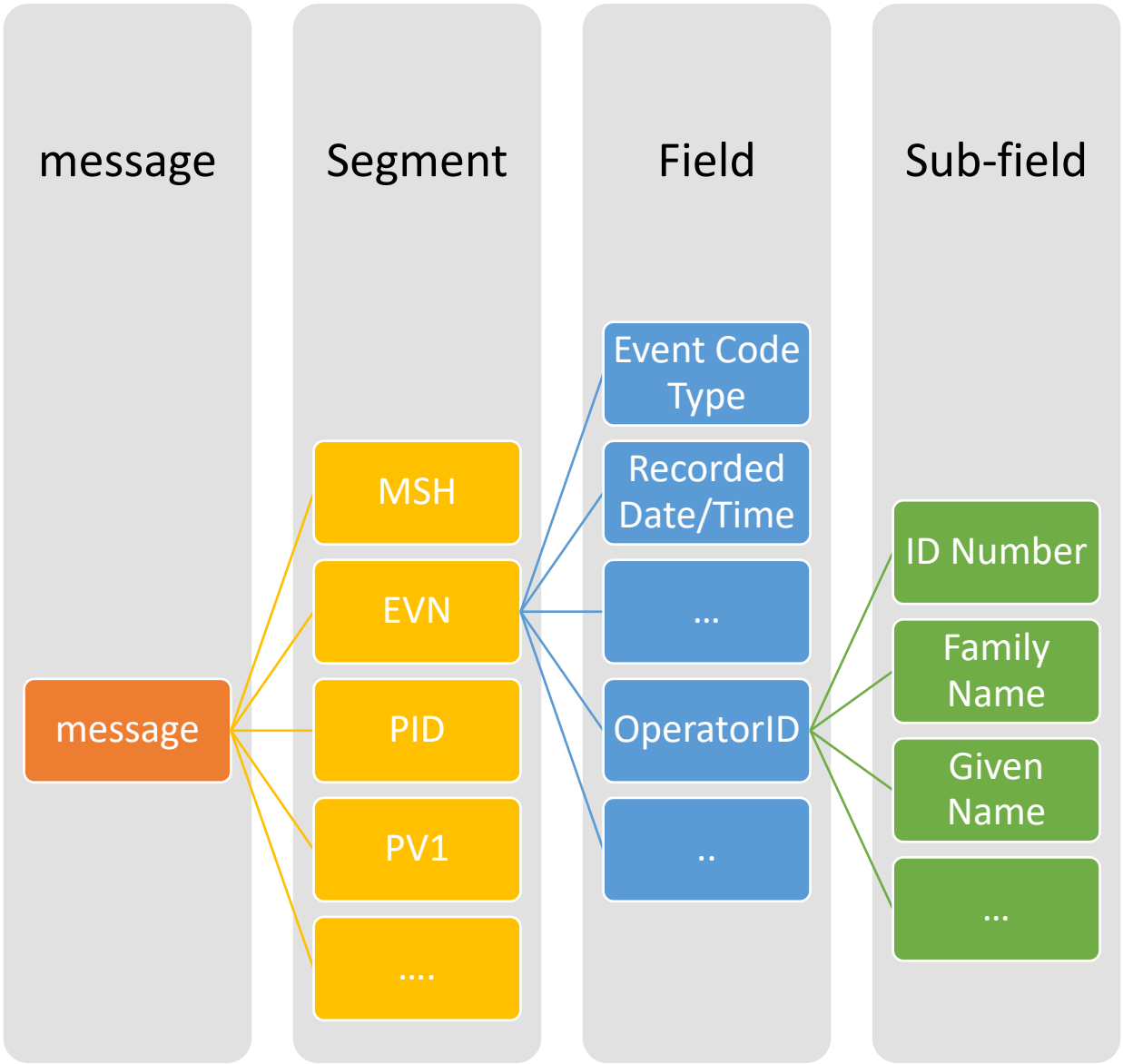
HL7 v2.x – example message

MSH|^~\&|SONHO|HSJ|RIS|HSJ|20080810090131||ADT^A01|SONHO01052901|P|2.4
EVN|A01|20080710090000||01||20080710090000
PID|||56782445^^^SNS^PT~999855750^^^HSJ^PI||LastName^FirstName^SecondName^SR||19620910|M||C|Example Avenue N389 1oDto^^Porto^^4200-526^Portugal^H|PT|224 231 123|||||0105I30001
PV1|||I|W^389^1^UABH^^^^3||||12345^MEDICO^SENHOR^J^^^MD^^^UAMC^L||67890^MEDICO^CONSULTA^X^^^MD^^^UAMC^L|MED|||||A0||13579^MEDICO^ADMISSAO^T^ ^^MD^^^UAMC^L ||INT1234^^^SONHO^FI^HSJ^20080709
OBX|1|NM|HT^HEIGHT^99LOC1||71|in^inches^ANSI+|||||F
OBX|2|NM|WT^WEIGHT^99LOC1||175|lb^pounds^ANSI+|||||F
AL1|1|DA|ASP^ASPIRIN^99LOC2|MO|GI DISTRESS

Functional Areas

ADT	Registration	Orders	Results
Financial	Patient	Immunization	Reporting
Clinical Trials	Scheduling	Master Files	Referrals

Message structure - overview



HL7 V3

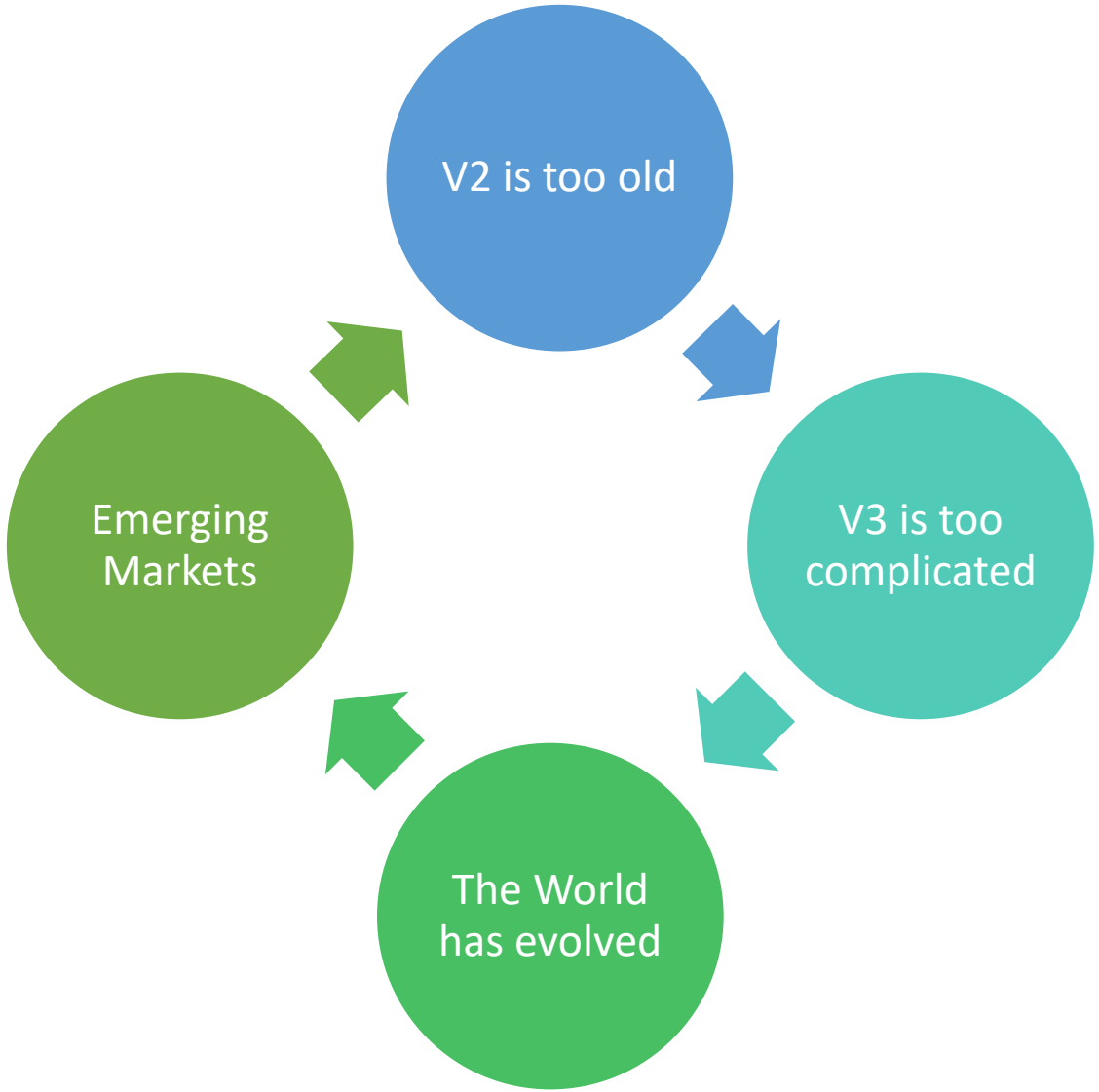
```
<?xml version="1.0" encoding="UTF-8"?>
<PRPA_IN101311UV02 xmlns="urn:hl7-org:v3"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    ITSVersion="XML_1.0" xsi:schemaLocation="urn:hl7-org:v3
    ../schemas/PRPA_IN101311UV02.xsd">
    ...
    <name use="SYL" >
        <given>นวนรรน</given>
        <family>ธีระอัมพรพันธุ์</family>
    </name>
    <name use="ABC">
        <given>Nawanan</given>
        <family>Theera-Ampornpunt</family>
    </name>
        <administrativeGenderCode code="M"/>
...
</PRPA_IN101311UV02>
```

HL7 V3

```
<?xml version="1.0" encoding="UTF-8"?>
<PRPA_IN101311UV02 xmlns="urn:hl7-org:v3"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    ITSVersion="XML_1.0" xsi:schemaLocation="urn:hl7-org:v3
    ../schemas/PRPA_IN101311UV02.xsd">
    ...
    <name use="SYL" >
        <given>นวนรรน</given>
        <family>ธีระอัมพรพันธุ์</family>
    </name>
    <name use="ABC">
        <given>Nawanan</given>
        <family>Theera-Ampornpunt</family>
    </name>
        <administrativeGenderCode code="M"/>
...
</PRPA_IN101311UV02>
```

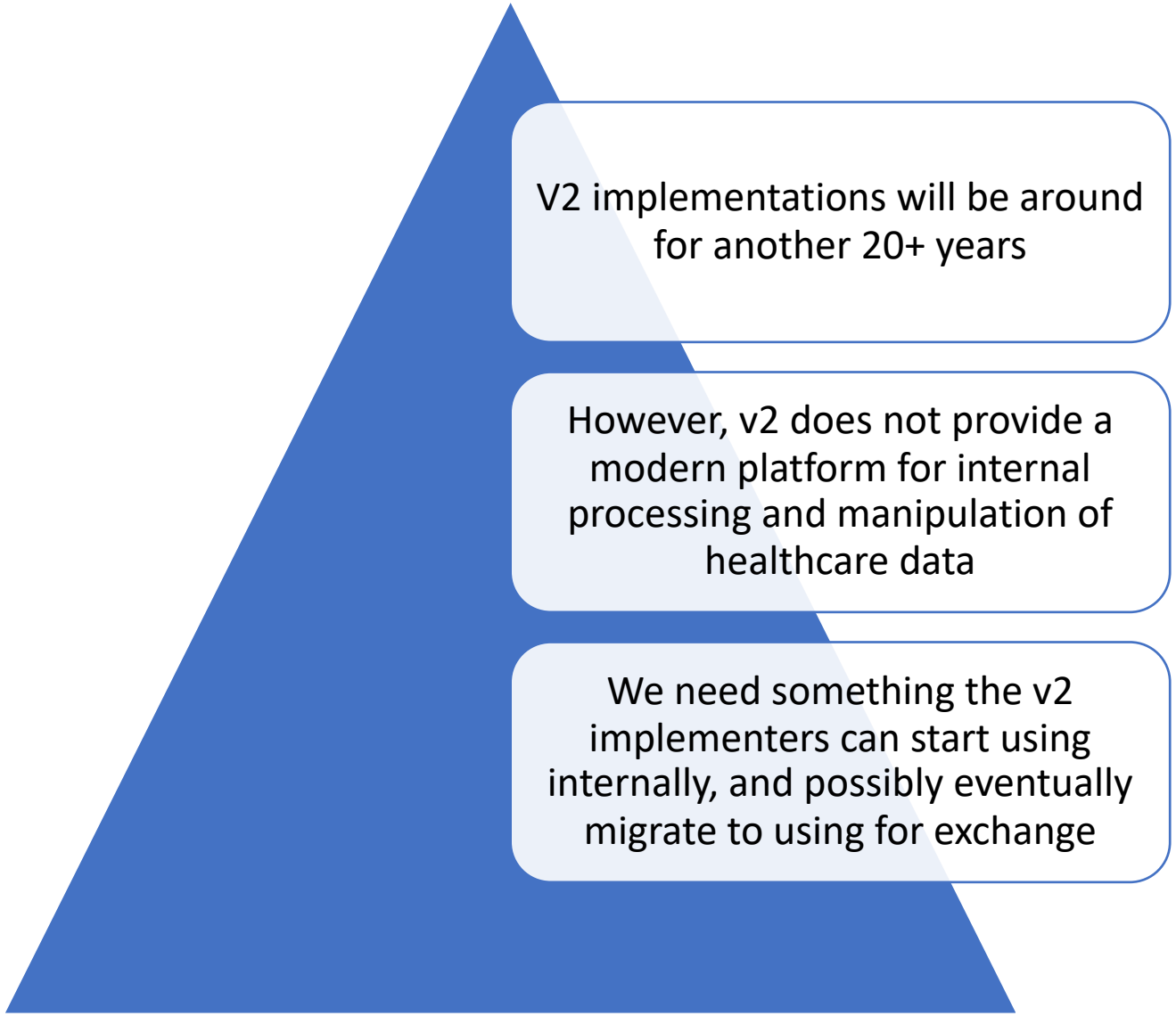
HL7 FHIR

Why FHIR?



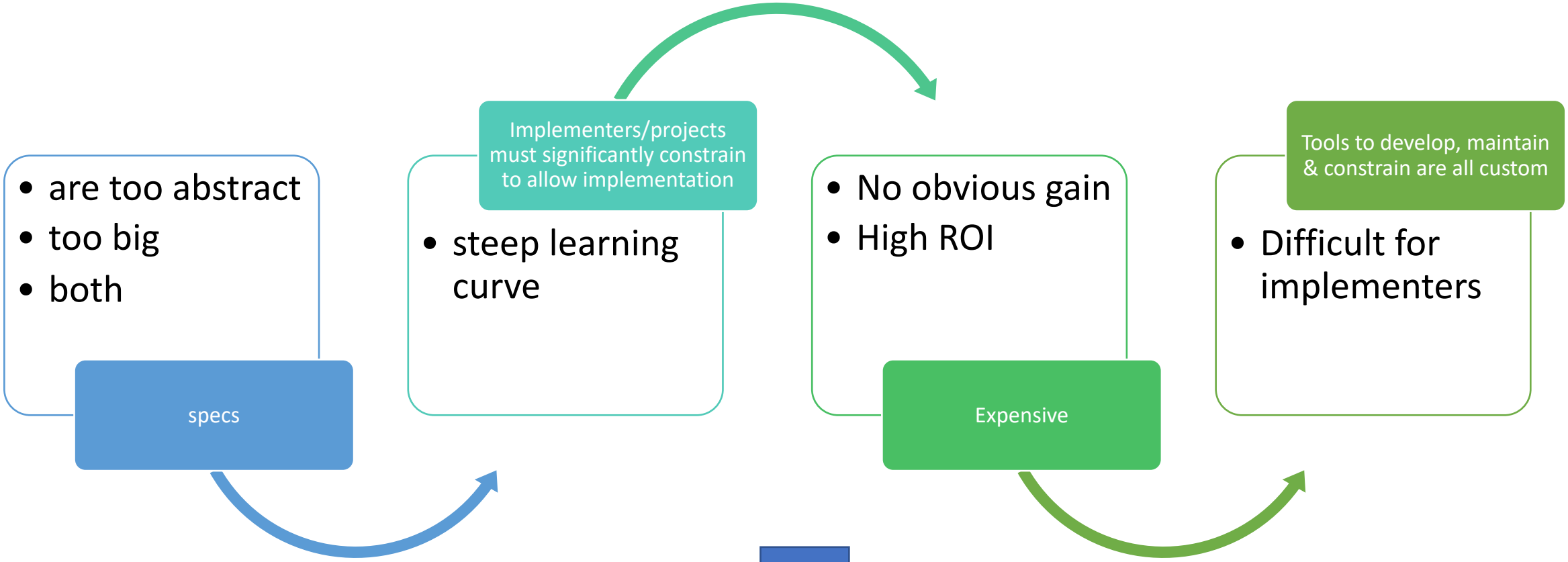
https://github.com/FHIR/documents/blob/master/presentations/Introduction%20to%20FHIR.pptx

Why FHIR?



https://github.com/FHIR/documents/blob/master/presentations/Introduction%20to%20FHIR.pptx

Why FHIR? – improving on what came before



Why FHIR? – improving on what came before

Development process is slow

Poor market penetration

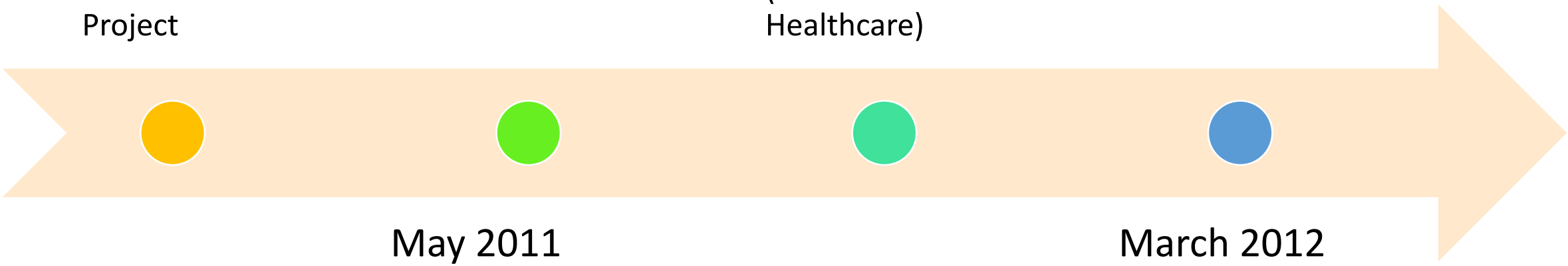
Very little up-take without major sponsorship (and investment) by large projects

With exception of CDA, **zero** direct implementation of HL7 v3 specs

And HL7 needs to to . . .

- The world has been changing
- Tech has changed
- Interoperability has changed
- Healthcare has changed
- **Did the standard change?**

FHIR



https://github.com/FHIR/documents/blob/master/presentations/Introduction%20to%20FHIR.pptx

FAST HEALTHCARE INTEROPERABILITY RESOURCES

FHIR

Not V4

Based on several things from v3

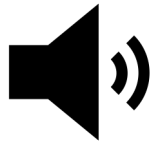
Drastic change

New approach

New tools

New methodology

But much more hidden



FIRE

3 FHIR Initial Editors

Lloyd Mckenzie

Grahame Grieve

Ewout Kramer

FHIR

Open source

- This is a big deal and the first effort in making healthcare integration more transparent and accessible. Putting it out in the open has created a **significant community including developers, vendors and enterprises**.

RESTful

- REST-based design brings a significant amount of benefit, namely that an API that adheres to the principles of REST does not require the **client to know anything about the structure of the API**. Rather, the server needs to provide whatever information the client needs to interact with the service.
- An architectural style for an application program interface (API) that uses HTTP requests to access and use data. That data can be used to GET, PUT, POST and DELETE data types, which refers to the reading, updating, creating and deleting of operations concerning resources.

Extensible

- Extensibility under the **RESTful context** ensures that additions can be easily tacked on to cover specific use cases without impacting the core models.

Composable

- Composability ensures that almost **any request can be cobbled** together using core models or resources and associated extensions.

Documentação

- Uniquely driven by the RESTful API approach, which **enforces good documentation** as a byproduct. A playable version of the FHIR APIs would be a nice to have. - fhirly

Suporte dos standard modernos da web

- XML, JSON, HTTP, Atom, OAuth, REST - these are the underlying technologies that FHIR leverages. These are **battle tested** and have been proven at scale and under significant security requirements.

https://datica.com/academy/introduction-to-fhir/

FHIR

- Only include data elements in the artifacts if 80% of all implementers of that artifact will use the data element

Design for the 80%, not 100%

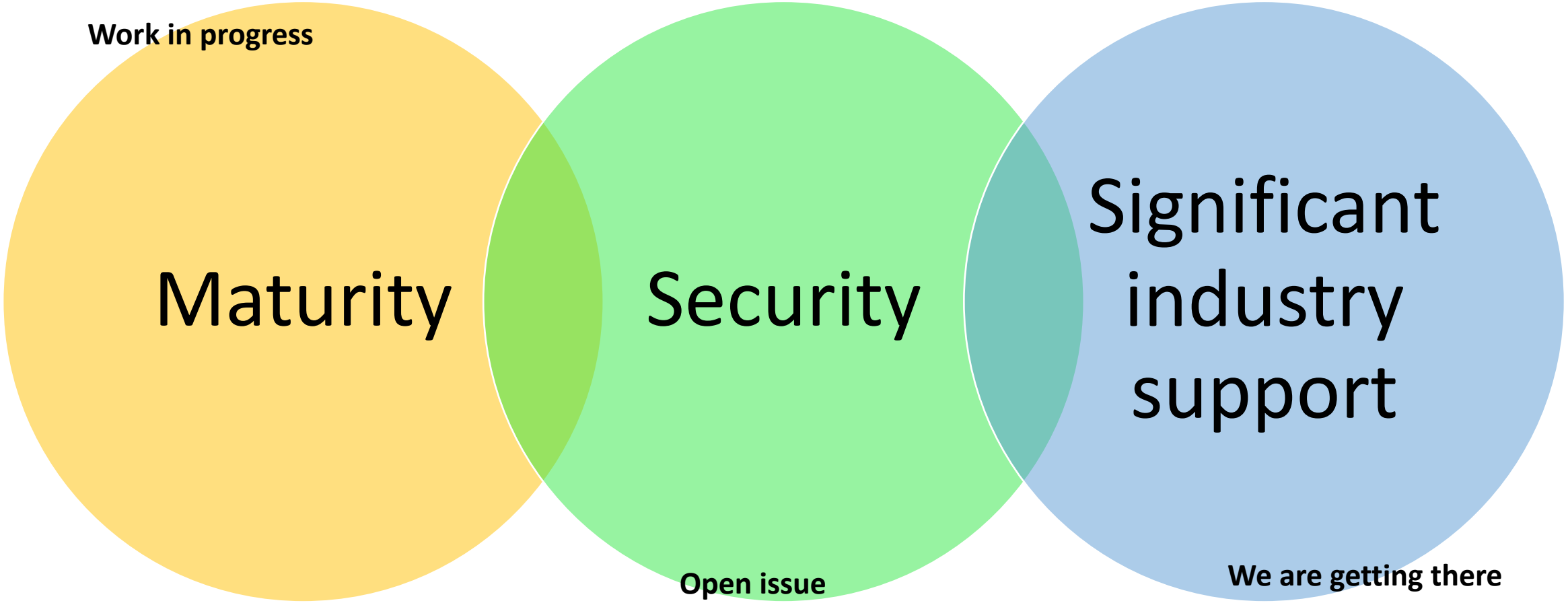
Allow easy extension for the remaining 20% of elements

- Guidance, not constraining

- Not what the modelers thought, or designers need to remember

Focus publication on documenting what the implementer needs

HOWEVER


Work in progress
Maturity
Security
Significant industry support
Open issue
We are getting there

A resource

Primary artifact

All defined by HL7

100-150 total for all of healthcare. **Ever**

Can be maintained separately

Based on REST concept of resources

A resource

Individuals

- Patient N
- Practitioner 3
- PractitionerRole 2
- RelatedPerson 2
- Person 2
- Group 1

Medications

- MedicationRequest 3
- MedicationAdministration 2
- MedicationDispense 2
- MedicationStatement 3
- Medication 3
- MedicationKnowledge 0
- Immunization 3
- ImmunizationEvaluation 0
- ImmunizationRecommendation 1

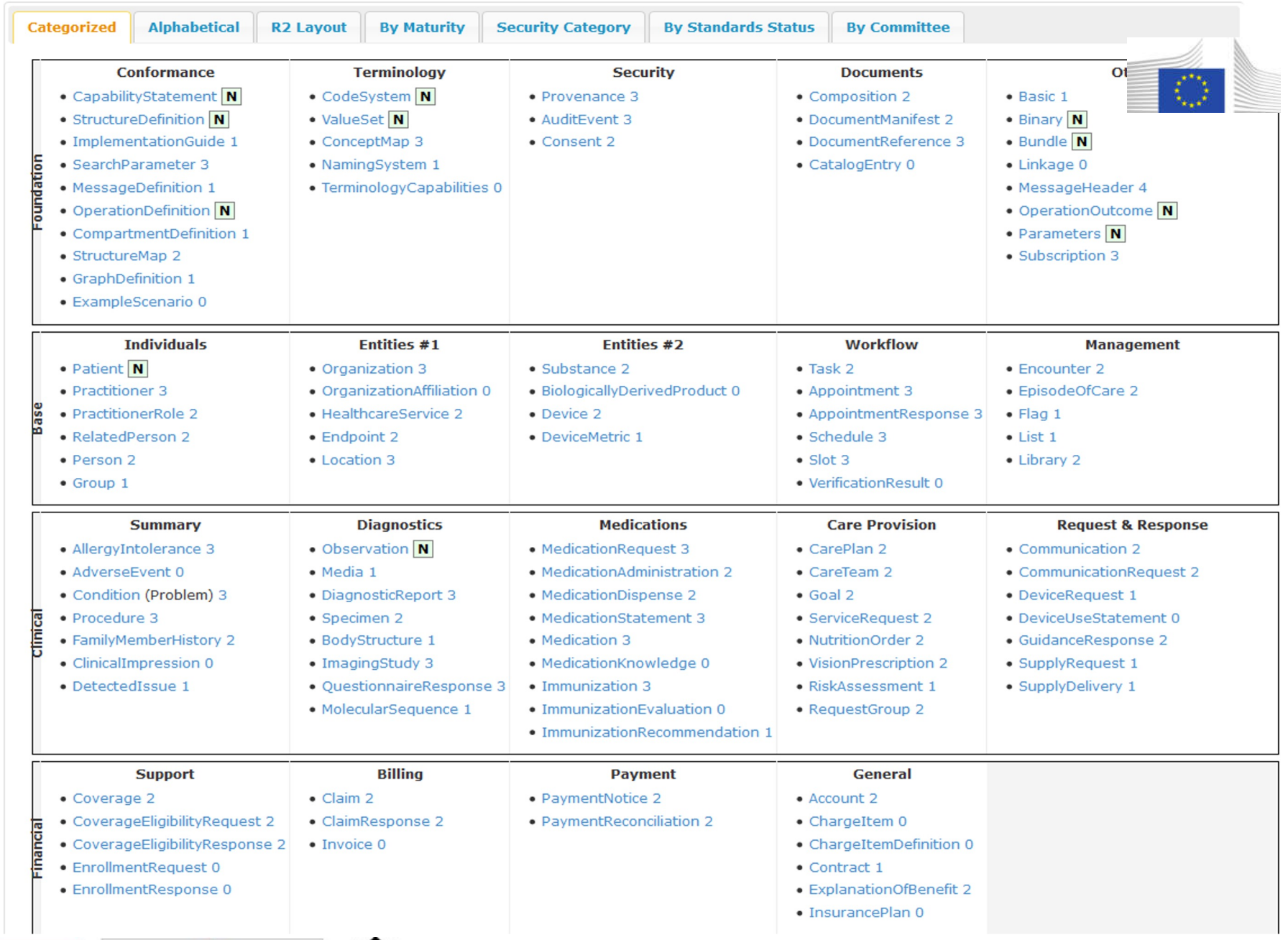
Foundation

Conformance

- CapabilityStatement N
- StructureDefinition N
- ImplementationGuide 1
- SearchParameter 3
- MessageDefinition 1
- OperationDefinition N
- CompartmentDefinition 1
- StructureMap 2
- GraphDefinition 1
- ExampleScenario 0

Also resources

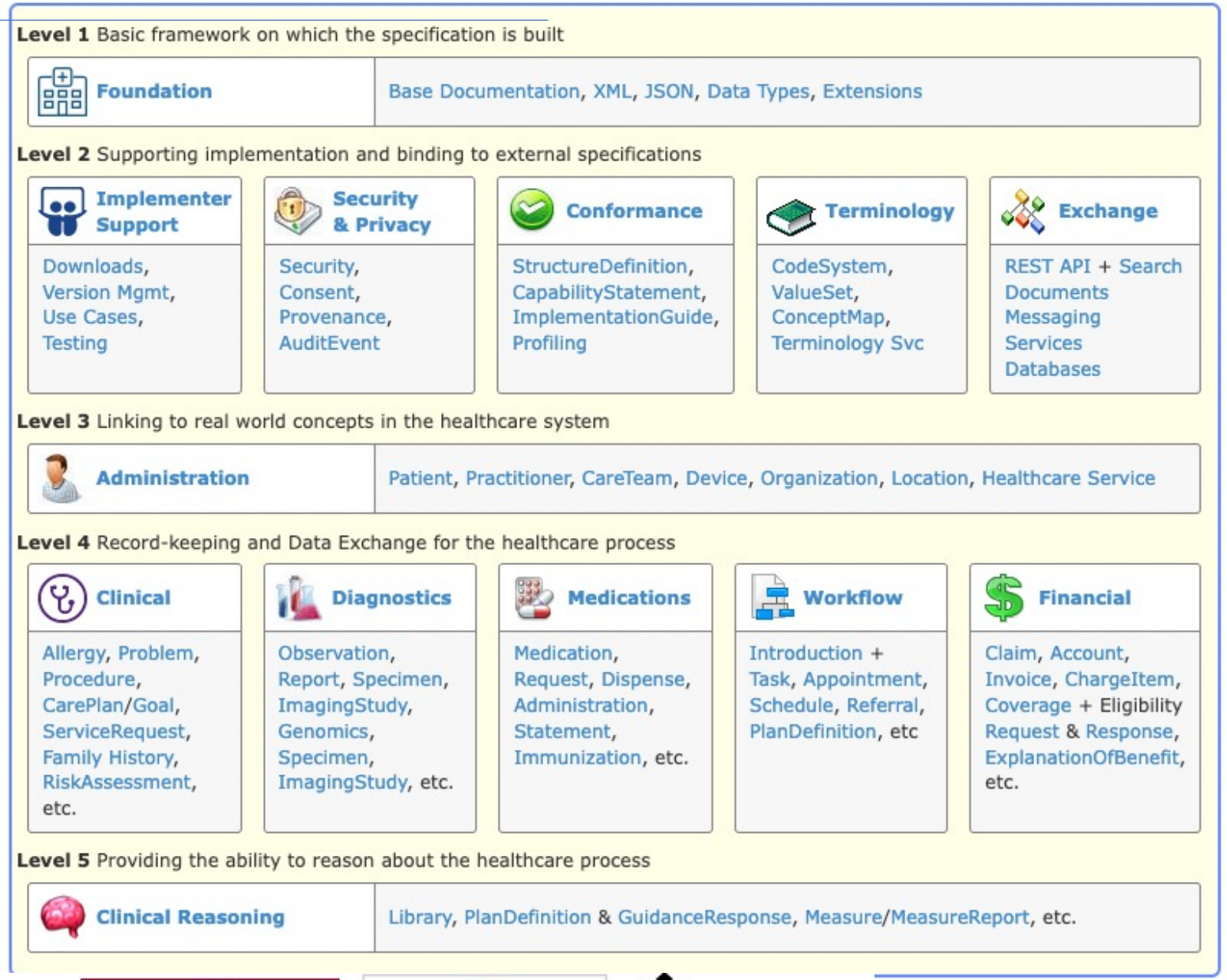
Resources



Available in:
https://www.hl7.org/fhir/

Resources

Everything is a resource in FHIR



Current standard:

https://www.hl7.org/fhir/

Development:

https://build.fhir.org/

Exercise

Introduction to the website

1. Find the Executive Summary
2. Find Developers section
3. Find FHIR Overview

1. Which characteristics are shared among every FHIR resource?
2. What are the interactions that the FHIR API provides?
3. Which are the modules refered in the FHIR specification?

Which characteristics are shared among every FHIR resource?

The basic building block in FHIR is a Resource. All exchangeable content is defined as a resource. Resources all share the following set of characteristics:

- A common way to define and represent them, building them from datatypes that define common reusable patterns of elements
- A common set of metadata
- A human readable part

http://hl7.org/fhir/overview.html

What are the interactions that the FHIR API provides?

For manipulation of resources, FHIR provides a REST API with a rich but simple set of interactions:

- Create = POST https://example.com/path/{resourceType}
- Read = GET https://example.com/path/{resourceType}/{id}
- Update = PUT https://example.com/path/{resourceType}/{id}
- Delete = DELETE https://example.com/path/{resourceType}/{id}
- Search = GET https://example.com/path/{resourceType}?search parameters...
- History = GET https://example.com/path/{resourceType}/{id}/_history
- Transaction = POST https://example.com/path/ *(POST a transaction bundle to the system)*
- Operation = GET https://example.com/path/{resourceType}/{id}/${opname}

The FHIR specification describes other kinds of exchanges beyond this simple RESTful API, including exchange of groups of resources as Documents, as Messages, and by using various types of Services.

http://hl7.org/fhir/overview-dev.html

Which are the modules refered in the FHIR specification?

Broadly, the FHIR specification is broken up into a set of modules:

- Foundation: The basic definitional infrastructure on which the rest of the specification is built
- Implementer Support: Services to help implementers make use of the specification
- Security & Privacy: Documentation and services to create and maintain security, integrity and privacy
- Conformance: How to test conformance to the specification, and define implementation guides
- Terminology: Use and support of terminologies and related artifacts
- Linked Data: Defined methods of exchange for resources
- Administration: Basic resources for tracking patients, practitioners, organizations, devices, substances, etc.
- Clinical: Core clinical content such as problems, allergies, and the care process (care plans, referrals) + more
- Medications: Medication management and immunization tracking
- Diagnostics: Observations, Diagnostic reports and requests + related content
- Workflow: Managing the process of care, and technical artifacts to do with obligation management
- Financial: Billing and Claiming support
- Clinical Reasoning: Clinical Decision Support and Quality Measures

Resources have a wide range of uses, from pure clinical content such as care plans and diagnostic reports to pure infrastructure such as Message Header and Capability Statements. They all share common technical characteristics (see below for a more formal definition), but they are used in totally different fashions. Note that you do not have to use REST to make use of resources.

http://hl7.org/fhir/overview.html

A resource

Hierarchy of elements

Each element has:

- a name
- either a datatype or nested elements
- optionality
- cardinality

Resources - Patient

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

Resources - Observation

Structure

Name	Flags	Card.	Type	Description & Constraints
Observation	I N		DomainResource	Measurements and simple assertions *+ Rule: dataAbsentReason SHALL only be present if Observation.value[x] is not present* *+ Rule: If Observation.code is the same as an Observation.component.code then the value element associated with the code SHALL NOT be present* Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	Business Identifier for observation
basedOn	Σ	0..*	Reference(CarePlan | DeviceRequest | ImmunizationRecommendation | MedicationRequest | NutritionOrder | ServiceRequest)	Fulfills plan, proposal or order
partOf	Σ	0..*	Reference(MedicationAdministration | MedicationDispense | MedicationStatement | Procedure | Immunization | ImagingStudy)	Part of referenced event
status	?! Σ	1..1	code	registered | preliminary | final | amended + ObservationStatus (Required)
category		0..*	CodeableConcept	Classification of type of observation Observation Category Codes (Preferred)
code	Σ	1..1	CodeableConcept	Type of observation (code / type) LOINC Codes (Example)
subject	Σ	0..1	Reference(Patient | Group | Device | Location)	Who and/or what the observation is about
focus	Σ TU	0..*	Reference(Any)	What the observation is about, when it is not about the subject of record
encounter	Σ	0..1	Reference(Encounter)	Healthcare event during which this observation is made
effective[x]	Σ	0..1		Clinically relevant time/time-period for observation
effectiveDateTime			dateTime	
effectivePeriod			Period	
effectiveTiming			Timing	
effectiveInstant			instant	
issued	Σ	0..1	instant	Date/Time this version was made available
performer	Σ	0..*	Reference(Practitioner | PractitionerRole | Organization | CareTeam | Patient | RelatedPerson)	Who is responsible for the observation
value[x]	Σ I	0..1		Actual result
valueQuantity			Quantity	
valueCodeableConcept			CodeableConcept	
valueString			string	
valueBoolean			boolean	
valueInteger			integer	
valueRange			Range	
valueRatio			Ratio	
valueSampledData			SampledData	

Resources - Encounter

Structure

Name	Flags	Card.	Type	Description & Constraints
Encounter	TU		DomainResource	An interaction during which services are provided to the patient Elements defined in Ancestors: id, meta, implicitRules, language, text, c modifierExtension
identifier	Σ	0..*	Identifier	Identifier(s) by which this encounter is known
status	?! Σ	1..1	code	planned | arrived | triaged | in-progress | onleave | finished | cancelled + EncounterStatus (Required)
statusHistory		0..*	BackboneElement	List of past encounter statuses
status		1..1	code	planned | arrived | triaged | in-progress | onleave | finished | cancelled + EncounterStatus (Required)
period		1..1	Period	The time that the episode was in the specified status
class	Σ	1..1	Coding	Classification of patient encounter V3 Value SetActEncounterCode (Extensible)
classHistory		0..*	BackboneElement	List of past encounter classes
class		1..1	Coding	inpatient | outpatient | ambulatory | emergency + V3 Value SetActEncounterCode (Extensible)
period		1..1	Period	The time that the episode was in the specified class
type	Σ	0..*	CodeableConcept	Specific type of encounter Encounter type (Example)
serviceType	Σ	0..1	CodeableConcept	Specific type of service Service type (Example)
priority		0..1	CodeableConcept	Indicates the urgency of the encounter v3 Code System ActPriority (Example)
subject	Σ	0..1	Reference(Patient | Group)	The patient or group present at the encounter
episodeOfCare	Σ	0..*	Reference(EpisodeOfCare)	Episode(s) of care that this encounter should be recorded against
basedOn		0..*	Reference(ServiceRequest)	The ServiceRequest that initiated this encounter
participant	Σ	0..*	BackboneElement	List of participants involved in the encounter
type	Σ	0..*	CodeableConcept	Role of participant in encounter Participant type (Extensible)
period		0..1	Period	Period of time during the encounter that the participant participated
individual	Σ	0..1	Reference(Practitioner | PractitionerRole | RelatedPerson)	Persons involved in the encounter other than the patient
appointment	Σ	0..*	Reference(Appointment)	The appointment that scheduled this encounter
period		0..1	Period	The start and end time of the encounter
length		0..1	Duration	Quantity of time the encounter lasted (less time absent)
reasonCode	Σ	0..*	CodeableConcept	Coded reason the encounter takes place Encounter Reason Codes (Preferred)
reasonReference	Σ	0..*	Reference(Condition | Procedure | Observation | ImmunizationRecommendation)	Reason the encounter takes place (reference)
diagnosis	Σ	0..*	BackboneElement	The list of diagnosis relevant to this encounter
condition	Σ	1..1	Reference(Condition | Procedure)	The diagnosis or procedure relevant to the encounter
use		0..1	CodeableConcept	Role that this diagnosis has within the encounter (e.g. admission, billing, discharge …) DiagnosisRole (Preferred)
rank		0..1	positiveInt	Ranking of the diagnosis (for each role type)
account		0..*	Reference(Account)	The set of accounts that may be used for billing for this Encounter
hospitalization		0..1	BackboneElement	Details about the admission to a healthcare service
preAdmissionIdentifier		0..1	Identifier	Pre-admission identifier
origin		0..1	Reference(Location | ization)	The location/organization from which the patient came before admission
			bleConcept	From where patient was admitted (physician referral, transfer)
			bleConcept	The type of hospital re-admission that has occurred (if any). If the value is absent, then this is not identified as a readmission

Resources – MedicationAdministration

Structure

Name	Flags	Card.	Type	Description & Constraints
MedicationAdministration	TU		DomainResource	Administration of medication to a patient Elements defined in Ancestors: id, meta, implicitRules, language, t modifierExtension
identifier		0..*	Identifier	External identifier
instantiates	Σ	0..*	uri	Instantiates protocol or definition
partOf	Σ	0..*	Reference(MedicationAdministration | Procedure)	Part of referenced event
status	?! Σ	1..1	code	in-progress | not-done | on-hold | completed | entered-in-error | stopped | unknown Medication administration status codes (Required)
statusReason		0..*	CodeableConcept	Reason administration not performed SNOMED CT Reason Medication Not Given Codes (Example)
category		0..1	CodeableConcept	Type of medication usage Medication administration category codes (Preferred)
medication[x]	Σ	1..1		What was administered SNOMED CT Medication Codes (Example)
medicationCodeableConcept			CodeableConcept	
medicationReference			Reference(Medication)	
subject	Σ	1..1	Reference(Patient | Group)	Who received medication
context		0..1	Reference(Encounter | EpisodeOfCare)	Encounter or Episode of Care administered as part of
supportingInformation		0..*	Reference(Any)	Additional information to support administration
effective[x]	Σ	1..1		Start and end time of administration
effectiveDateTime			dateTime	
effectivePeriod			Period	
performer	Σ	0..*	BackboneElement	Who performed the medication administration and what they did
function		0..1	CodeableConcept	Type of performance Medication administration performer function codes (Example)
actor	Σ	1..1	Reference(Practitioner | PractitionerRole | Patient | RelatedPerson | Device)	Who performed the medication administration
reasonCode		0..*	CodeableConcept	Reason administration performed Reason Medication Given Codes (Example)
reasonReference		0..*	Reference(Condition | Observation | DiagnosticReport)	Condition or observation that supports why the medication was administered
request		0..1	Reference(MedicationRequest)	Request administration performed against
device		0..*	Reference(Device)	Device used to administer
note		0..*	Annotation	Information about the administration
dosage	I	0..1	BackboneElement	Details of how medication was taken *+ Rule: SHALL have at least one of dosage.dose or dosage.rate[x]*
text		0..1	string	Free text dosage instructions e.g. SIG
site		0..1	CodeableConcept	Body site administered to SNOMED CT Anatomical Structure for Administration Site Codes (Example)
route		0..1	CodeableConcept	Path of substance into body SNOMED CT Route Codes (Example)
method		0..1	CodeableConcept	How drug was administered SNOMED CT Administration Method Codes (Example)
dose		0..1	SimpleQuantity	Amount of medication per dose
rate[x]		0..1		Dose quantity per unit of time
rateRatio			Ratio	
rateQuantity			SimpleQuantity	
			nce(Provenance)	A list of events of interest in the lifecycle

Resources - procedure

Structure

Name	Flags	Card.	Type	Description & Constraints
Procedure	TU		DomainResource	An action that is being or was performed on a patient Elements defined in Ancestors: id, meta, implicitRules, language, text, contain... ion
identifier	Σ	0..*	Identifier	External Identifiers for this procedure
instantiatesCanonical	Σ	0..*	canonical(PlanDefinition | ActivityDefinition | Measure | OperationDefinition | Questionnaire)	Instantiates FHIR protocol or definition
instantiatesUri	Σ	0..*	uri	Instantiates external protocol or definition
basedOn	Σ	0..*	Reference(CarePlan | ServiceRequest)	A request for this procedure
partOf	Σ	0..*	Reference(Procedure | Observation | MedicationAdministration)	Part of referenced event
status	?! Σ	1..1	code	preparation | in-progress | not-done | on-hold | stopped | completed | entered-in-error | unknown EventStatus (Required)
statusReason	Σ	0..1	CodeableConcept	Reason for current status Procedure Not Performed Reason (SNOMED-CT) (Example)
category	Σ	0..1	CodeableConcept	Classification of the procedure Procedure Category Codes (SNOMED CT) (Example)
code	Σ	0..1	CodeableConcept	Identification of the procedure Procedure Codes (SNOMED CT) (Example)
subject	Σ	1..1	Reference(Patient | Group)	Who the procedure was performed on
encounter	Σ	0..1	Reference(Encounter)	Encounter created as part of
performed[x]	Σ	0..1		When the procedure was performed
performedDateTime			dateTime	
performedPeriod			Period	
performedString			string	
performedAge			Age	
performedRange			Range	
recorder	Σ	0..1	Reference(Patient | RelatedPerson | Practitioner | PractitionerRole)	Who recorded the procedure
asserter	Σ	0..1	Reference(Patient | RelatedPerson | Practitioner | PractitionerRole)	Person who asserts this procedure
performer	Σ	0..*	BackboneElement	The people who performed the procedure
function	Σ	0..1	CodeableConcept	Type of performance Procedure Performer Role Codes (Example)
actor	Σ	1..1	Reference(Practitioner | PractitionerRole | Organization | Patient | RelatedPerson | Device)	The reference to the practitioner
onBehalfOf		0..1	Reference(Organization)	Organization the device or practitioner was acting for
location	Σ	0..1	Reference(Location)	Where the procedure happened
reasonCode	Σ	0..*	CodeableConcept	Coded reason procedure performed Procedure Reason Codes (Example)
reasonReference	Σ	0..*	Reference(Condition | Observation | Procedure | DiagnosticReport | DocumentReference)	The justification that the procedure was performed
bodySite	Σ	0..*	CodeableConcept	Target body sites SNOMED CT Body Structures (Example)
outcome	Σ	0..1	CodeableConcept	The result of procedure Procedure Outcome Codes (SNOMED CT) (Example)
report		0..*	Reference(DiagnosticReport | DocumentReference | Composition)	Any report resulting from the procedure
complication		0..*	CodeableConcept	Complication following the procedure Condition/Problem/Diagnosis Codes (Example)
			Reference(Condition)	...the procedure
			CodeableConcept	Instructions for follow up Procedure Follow up Codes (SNOMED CT) (Example)
note			Annotation	Additional information about the procedure

Resources - Patient

1. Each line represent a attribute/element
2. Tree formation (nesting)
3. Icon is allusive to the data type
4. The [x] symbolizes a polymorphic attribute

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

Resources - Patient

1. Summary Σ
2. Invariant I
3. Modifier element ?!

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address		0..1	Address	Address for the contact person
gender		0..1	code	male | female | other | unknown AdministrativeGender (Required)
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Resources - Patient

Refers to optionality and cardinality

0..* vs 1..* vs 1..1

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Resources - Patient

From the simplest to the very complex

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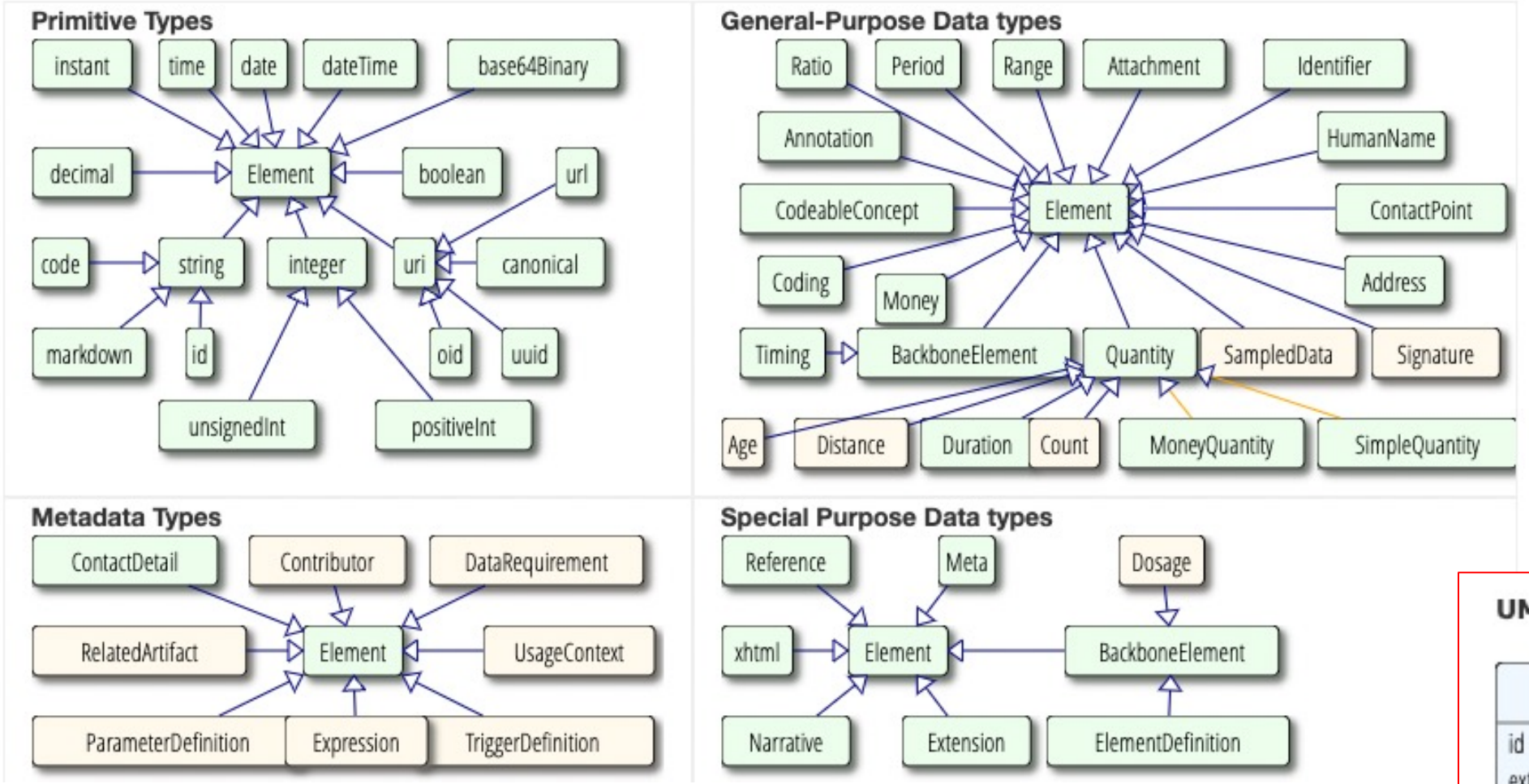
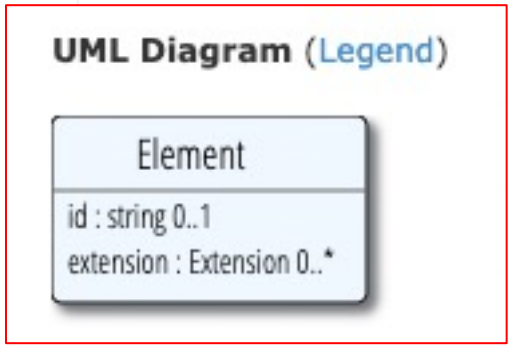
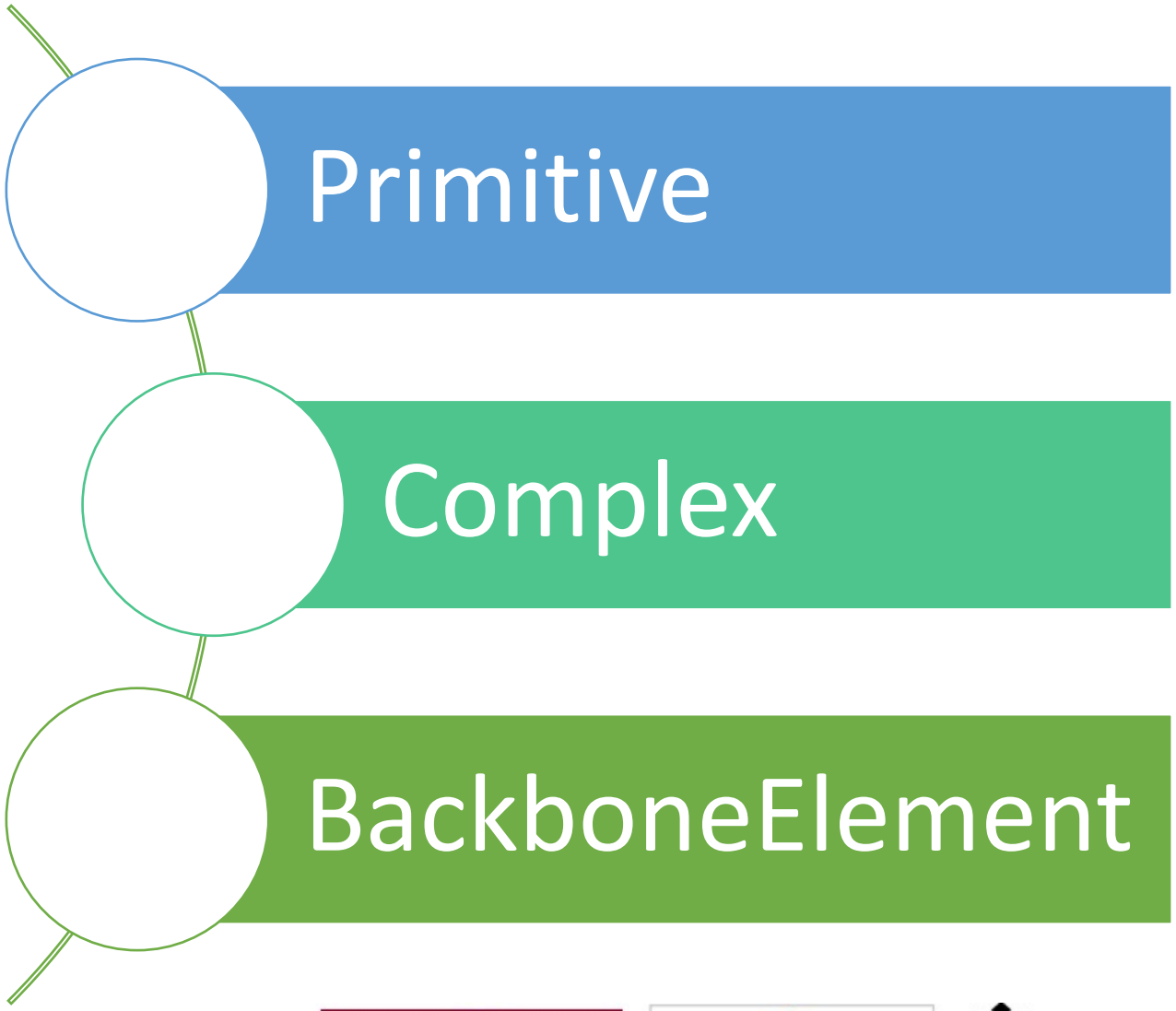
Resources - Patient





https://github.com/FHIR/documents/blob/master/presentations/Introduction%20to%20FHIR.pptx

Data Types



Only one value: integer, string, boolean, etc

Cluster of reusable elements: CodeableConcept, Quantity, Identifier, etc

Most complex – varying datatypes and hierarchy

Resources - Patient

primitive

boolean	true | false
	Regex: `true|false`

complex

Name	Flags	Card.	Type
Address	Σ N		Element
use	?! Σ	0..1	code
type	Σ	0..1	code
text	Σ	0..1	string
line	Σ	0..*	string
city	Σ	0..1	string
district	Σ	0..1	string
state	Σ	0..1	string
postalCode	Σ	0..1	string
country	Σ	0..1	string
period	Σ	0..1	Period

Documentation for this format

backboneElement

Name	Flags	Card.	Type
Dosage	Σ TU		BackBoneElement
sequence	Σ	0..1	integer
text	Σ	0..1	string
additionalInstruction	Σ	0..*	CodeableConcept
patientInstruction	Σ	0..1	string
timing	Σ	0..1	Timing
asNeeded[x]	Σ	0..1	
asNeededBoolean			boolean
asNeededCodeableConcept			CodeableConcept
site	Σ	0..1	CodeableConcept
route	Σ	0..1	CodeableConcept
method	Σ	0..1	CodeableConcept
doseAndRate	Σ	0..*	Element
type	Σ	0..1	CodeableConcept
dose[x]	Σ	0..1	
doseRange			Range
doseQuantity			SimpleQuantity
rate[x]	Σ	0..1	
rateRatio			Ratio
rateRange			Range
rateQuantity			SimpleQuantity
maxDosePerPeriod	Σ	0..1	Ratio
maxDosePerAdministration	Σ	0..1	SimpleQuantity
maxDosePerLifetime	Σ	0..1	SimpleQuantity

Resources - Patient

Everything is FHIR is a resource and is properly defined

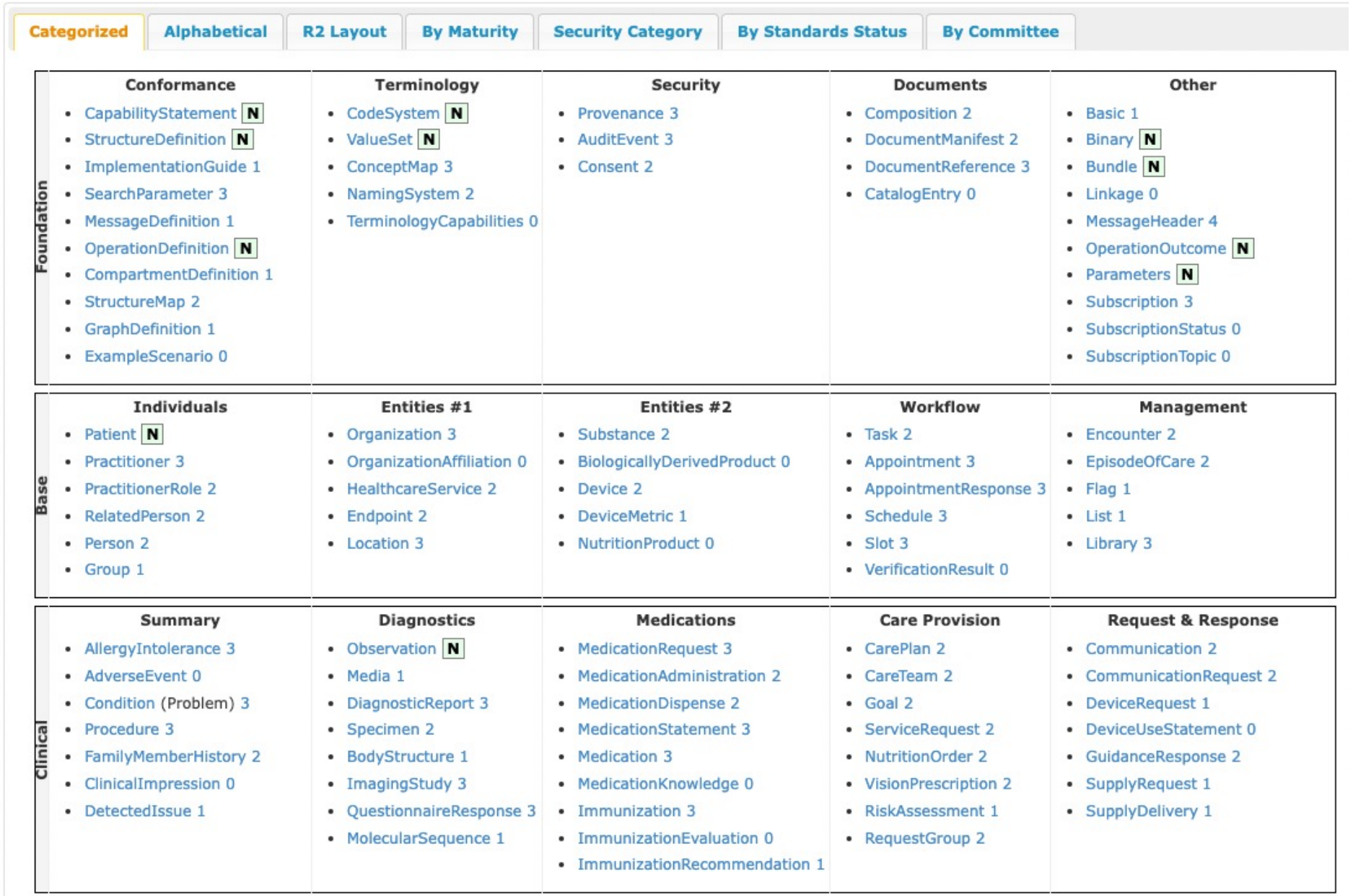
Name	Flags	Card.	Type	Description & Constraints
Patient	N		DomainResource	Information about an individual or animal receiving health care services Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	An identifier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

Name	Flags	Card.	Type
Patient	N		DomainResource
identifier	Σ	0..*	Identifier
active	?! Σ	0..1	boolean
name	Σ	0..*	HumanName
telecom	Σ	0..*	ContactPoint
gender	Σ	0..1	code
birthDate	Σ	0..1	date
deceased[x]	?! Σ	0..1	
deceasedBoolean			boolean
deceasedDateTime			dateTime
address	Σ	0..*	Address
maritalStatus		0..1	CodeableConcept
multipleBirth[x]		0..1	
multipleBirthBoolean			boolean
multipleBirthInteger			integer
photo		0..*	Attachment
contact	I	0..*	BackboneElement
relationship		0..*	CodeableConcept
name		0..1	HumanName
telecom		0..*	ContactPoint
address		0..1	Address
gender		0..1	code
organization	I	0..1	Reference(Organization)
period		0..1	Period
communication		0..*	BackboneElement
language		1..1	CodeableConcept
preferred		0..1	boolean
generalPractitioner		0..*	Reference(Organization | Practitioner | PractitionerRole)
managingOrganization	Σ	0..1	Reference(Organization)
link	?! Σ	0..*	BackboneElement

Structure

Name	Flags	Card.	Type
DomainResource	«A» N		Resource
text		0..1	Narrative
contained	I	0..*	Resource
extension		0..*	Extension
modifierExtension	?!	0..*	Extension

Name	Flags	Card.	Type
Resource	«A» N		n/a
id	Σ	0..1	string
meta	Σ	0..1	Meta
implicitRules	?! Σ	0..1	uri
language		0..1	code



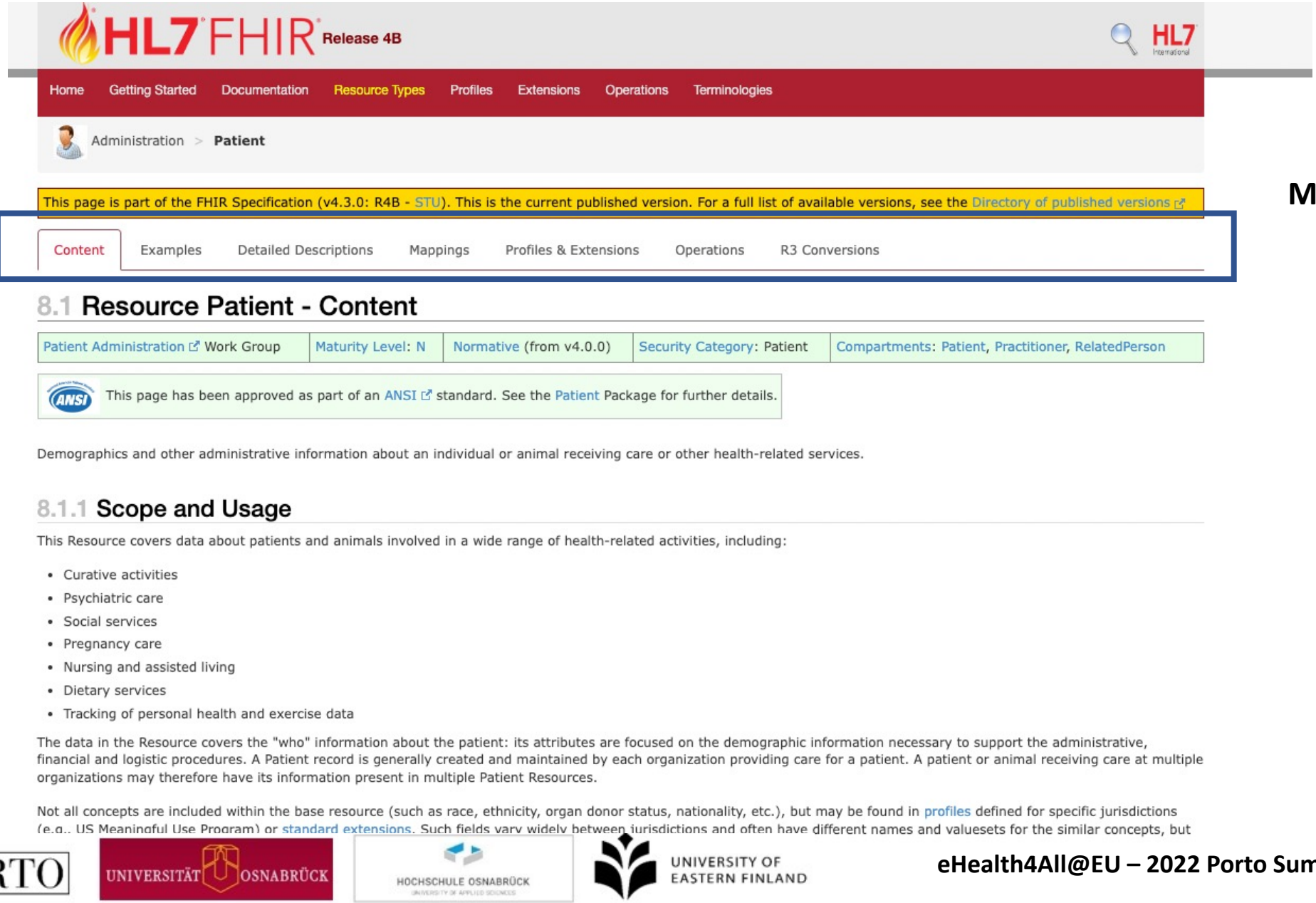
From foundation to clinical

Structure

Name	Flags	Card.	Type
AllergyIntolerance	TU		DomainResource
identifier	Σ	0..*	Identifier
clinicalStatus	?! Σ I	0..1	CodeableConcept
verificationStatus	?! Σ I	0..1	CodeableConcept
type	Σ	0..1	code
category	Σ	0..*	code
criticality	Σ	0..1	code
code	Σ	0..1	CodeableConcept
patient	Σ	1..1	Reference(Patient)
encounter		0..1	Reference(Encounter)
onset[x]		0..1	
onsetDateTime			dateTime
onsetAge			Age
onsetPeriod			Period
onsetRange			Range

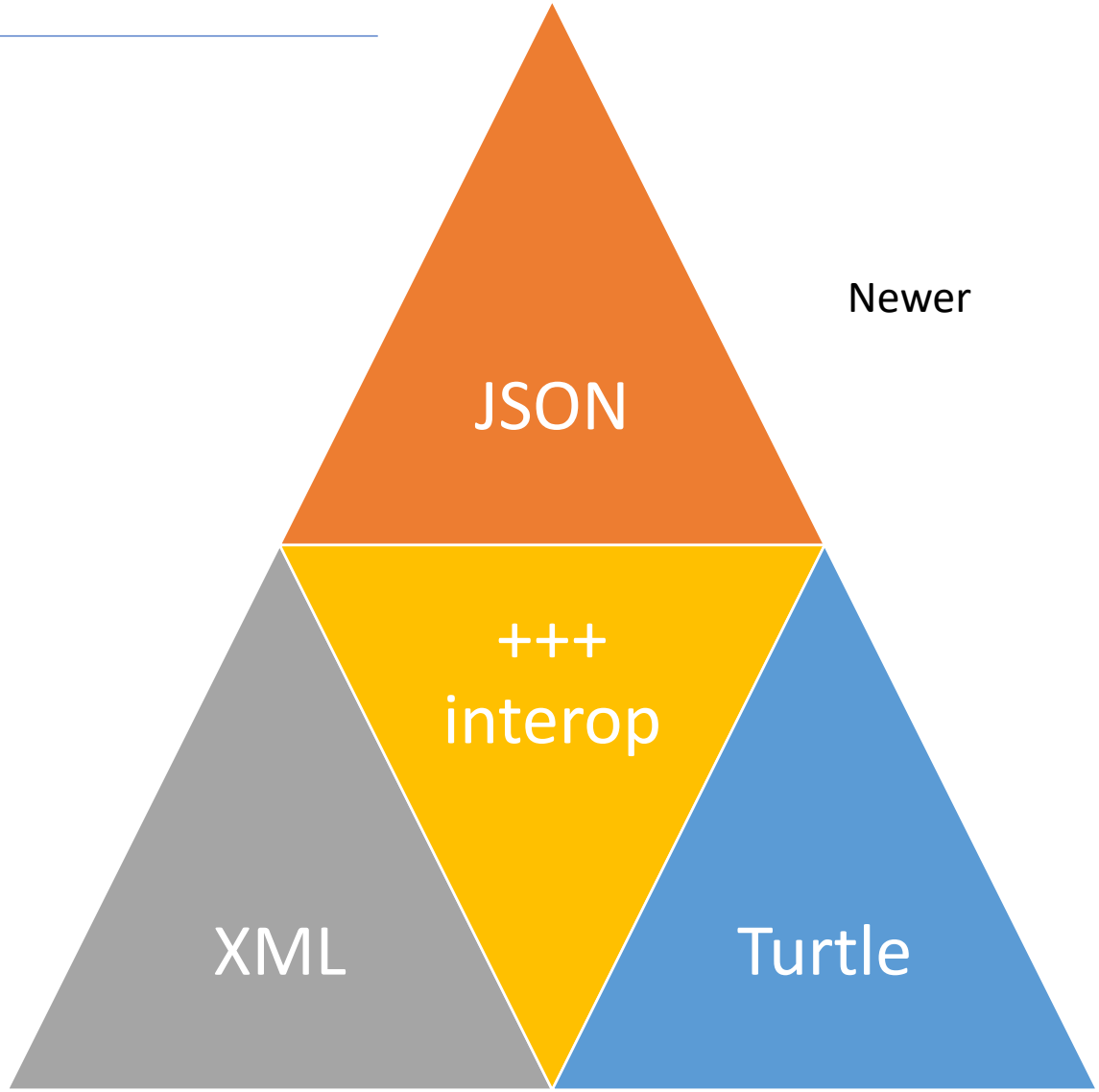
Name	Flags	Card.	Type
Bundle	N		Resource
identifier	Σ	0..1	Identifier
type	Σ	1..1	code
timestamp	Σ	0..1	instant
total	Σ I	0..1	unsignedInt
link	Σ	0..*	BackboneElement
relation	Σ	1..1	string
url	Σ	1..1	uri
entry	Σ I	0..*	BackboneElement
link	Σ	0..*	see link

Resources



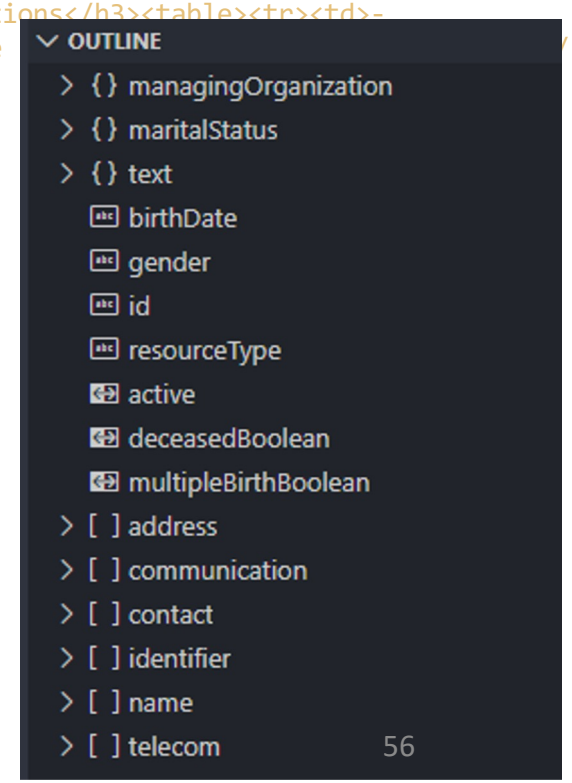
Main resource page

FHIR sintaxe

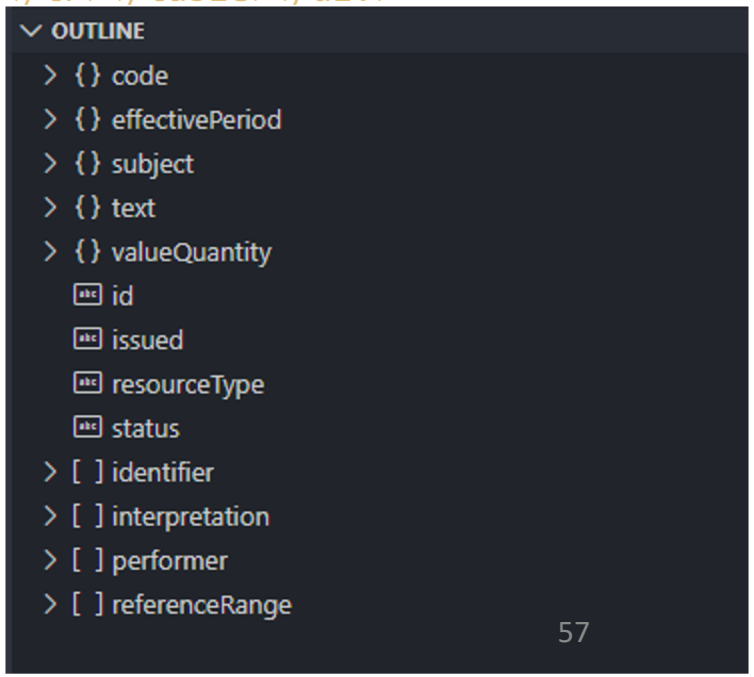


FHIR actually


```
{
    "resourceType": "Patient",
    "id": "f001",
    "text": {
        "status": "generated",
        "div": "<div xmlns=\"http://www.w3.org/1999/xhtml\"><p><b>Generated Narrative with Details</b></p><p><b>id</b>: f001</p><p><b>identifier</b>: 738472983
(USUAL), ?? (USUAL)</p><p><b>active</b>: true</p><p><b>name</b>: Pieter van de Heuvel </p><p><b>telecom</b>: ph: 0648352638(MOBILE), p.heuvel@gmail.com(HOME)</p><p
><b>gender</b>: male</p><p><b>birthDate</b>: 17/11/1944</p><p><b>deceased</b>: false</p><p><b>address</b>: Van Egmondkade 23 Amsterdam 1024 RJ NLD (HOME)</p><p><b>
maritalStatus</b>: Getrouwd <span>(Details : {http://terminology.hl7.org/CodeSystem/v3-
MaritalStatus code 'M' = 'Married', given as 'Married'})</span></p><p><b>multipleBirth</b>: true</p><h3>Contacts</h3><table><tr><td>-
</td><td><b>Relationship</b></td><td><b>Name</b></td><td><b>Telecom</b></td></tr><tr><td>*</td><td>Emergency Contact <span>(Details : {http://terminology.hl7.org/C
odeSystem/v2-
0131 code 'C' = 'Emergency Contact)</span></td><td>Sarah Abels </td><td>ph: 0690383372(MOBILE)</td></tr></table><h3>Communications</h3><table><tr><td>-
</td><td><b>Language</b></td><td><b>Preferred</b></td></tr><tr><td>*</td><td>Nederlands <span>(Details : {urn:ietf:bcp:47 code
span></td><td>true</td></tr></table><p><b>managingOrganization</b>: <a>Burgers University Medical Centre</a></p></div>"
    },
    "identifier": [
        {
            "use": "usual",
            "system": "urn:oid:2.16.840.1.113883.2.4.6.3",
            "value": "738472983"
        },
        {
            "use": "usual",
            "system": "urn:oid:2.16.840.1.113883.2.4.6.3"
        }
    ],
    "active": true,
    "name": [
        {
            "use": "usual",
            "family": "van de Heuvel",
            "given": [
                "Pieter"
```

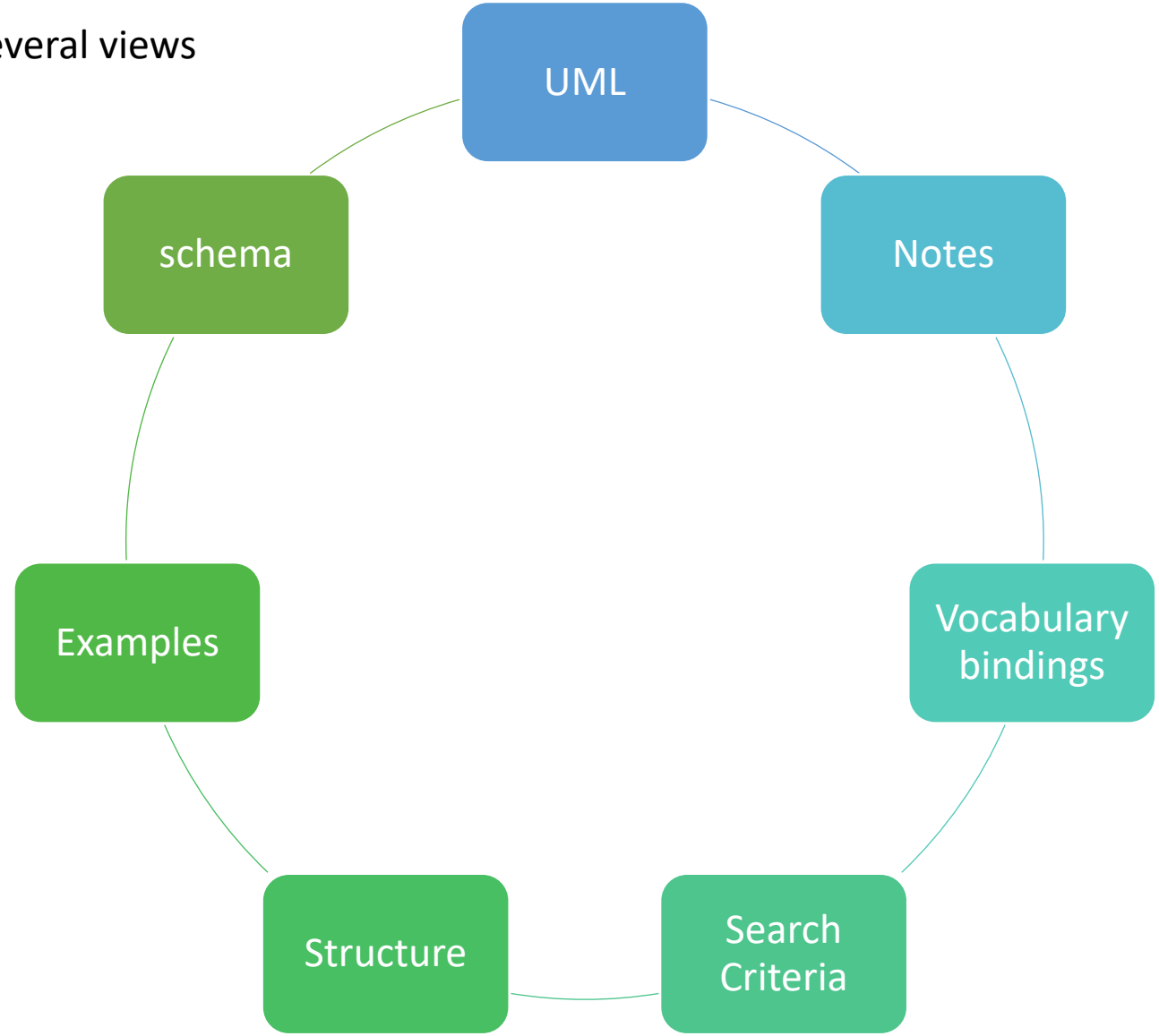



```
{
    "resourceType": "Observation",
    "id": "f001",
    "text": {
        "status": "generated",
        "div": "<div xmlns=\"http://www.w3.org/1999/xhtml\"><p><b>Generated Narrative with Details</b></p><p><b>id</b>:
f001</p><p><b>identifier</b>: 6323 (OFFICIAL)</p><p><b>status</b>: final</p><p><b>code</b>: Glucose [Moles/volume] in Bl
ood <span>(Details : {LOINC code '15074-
8' = 'Glucose [Moles/volume] in Blood', given as 'Glucose [Moles/volume] in Blood'})</span></p><p><b>subject</b>: <a>P.
van de Heuvel</a></p><p><b>effective</b>: 02/04/2013 9:30:10 AM --
&gt; (ongoing)</p><p><b>issued</b>: 03/04/2013 3:30:10 PM</p><p><b>performer</b>: <a>A. Langeveld</a></p><p><b>value</b>
: 6.3 mmol/l<span> (Details: UCUM code mmol/L = 'mmol/L')</span></p><p><b>interpretation</b>: High <span>(Details : {htt
p://terminology.hl7.org/CodeSystem/v3-
ObservationInterpretation code 'H' = 'High', given as 'High'})</span></p><h3>ReferenceRanges</h3><table><tr><td>-
</td><td><b>Low</b></td><td><b>High</b></td></tr><tr><td>*</td><td>3.1 mmol/l<span> (Details: UCUM code mmol/L = 'mmol/L
')</span></td><td>6.2 mmol/l<span> (Details: UCUM code mmol/L = 'mmol/L')</span></td></tr></table></div>"
    },
    "identifier": [
        {
            "use": "official",
            "system": "http://www.bmc.nl/zorgportal/identifiers/observations",
            "value": "6323"
        }
    ],
    "status": "final",
    "code": {
        "coding": [
            {
                "system": "http://loinc.org",
                "code": "15074-8",
                "display": "Glucose [Moles/volume] in Blood"
```

Resources

Each resource is published with several views covering different aspects



https://github.com/HL7/documents/blob/master/presentations/Introduction%20to%20FHIR.pptx

Resources

Every resource definition is made to look similar and relatable

Scope and Usage

Resource Content

Terminology Bindings

Constraints

Specific parameters

Search Parameters

Notes

Resources - Scope and Usage

Measurements and simple assertions made about a patient, device or other subject.

10.1.1 Scope and Usage

This resource is an *event resource* from a FHIR workflow perspective - see Workflow.

Observations are a central element in healthcare, used to support diagnosis, monitor progress, determine baselines and patterns and even capture demographic characteristics. Most observations are simple name/value pair assertions with some metadata, but some observations group other observations together logically, or even are multi-component observations. Note that the DiagnosticReport resource provides a clinical or workflow context for a set of observations and the Observation resource is referenced by DiagnosticReport to represent laboratory, imaging, and other clinical and diagnostic data to form a complete report.

Uses for the Observation resource include:

- Vital signs such as body weight, blood pressure, and temperature
- Laboratory Data like blood glucose, or an estimated GFR
- Imaging results like bone density or fetal measurements
- Clinical Findings* such as abdominal tenderness
- Device measurements such as EKG data or Pulse Oximetry data
- Clinical assessment tools such as APGAR or a Glasgow Coma Score
- Personal characteristics: such as eye-color
- Social history like tobacco use, family support, or cognitive status
- Core characteristics like pregnancy status, or a death assertion

*The boundaries between clinical findings and disorders remains a challenge in medical ontology. Refer the Boundaries section below and in Condition for general guidance. These boundaries can be clarified by profiling Observation for a particular use case.

Resources - Content

Structure

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

Resources - Bindings

Bindings

What are coded datatypes

What are terminologies

Resources - Bindings

Coded Elements

Code

Simplest one. Only has a single attribute

Name	Flags	Card.	Type	Description & Constraints
Observation	I N		DomainResource	Measurements and simple assertions + *Rule: dataAbsentReason SHALL only be present if Observatio* + *Rule: If Observation.code is the same as an Observation.com* *element associated with the code SHALL NOT be present* Elements defined in Ancestors: id, meta, implicitRules, languag modifierExtension
identifier	Σ	0..*	Identifier	Business Identifier for observation
basedOn	Σ	0..*	Reference(CarePlan | DeviceRequest | ImmunizationRecommendation | MedicationRequest | NutritionOrder | ServiceRequest)	Fulfills plan, proposal or order
partOf	Σ	0..*	Reference(MedicationAdministration | MedicationDispense | MedicationStatement | Procedure | Immunization | ImagingStudy)	Part of referenced event
status	?! Σ	1..1	code	registered | preliminary | final | amended + ObservationStatus (Required)

”nothing more” than a string /piece of text that should be in a list of permitted

Resources - Bindings

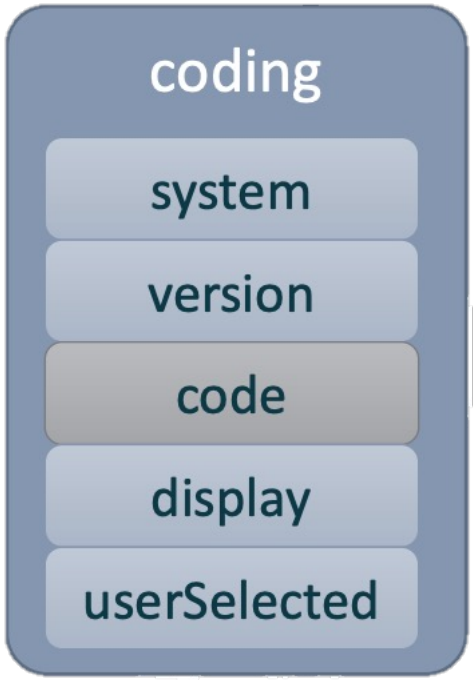
Coded Elements

Code

Simplest one. Only has a single attribute

Coding

Adds information to the code, like system and version



Structure

Name	Flags	Card.	Type	Description & Constraints
Coding	Σ N		Element	A reference to a code defined by a terminology system Elements defined in Ancestors: id, extension
system	Σ	0..1	uri	Identity of the terminology system
version	Σ	0..1	string	Version of the system - if relevant
code	Σ	0..1	code	Symbol in syntax defined by the system
display	Σ	0..1	string	Representation defined by the system
userSelected	Σ	0..1	boolean	If this coding was chosen directly by the user

Documentation for this format

System is similar to the owner of the code.

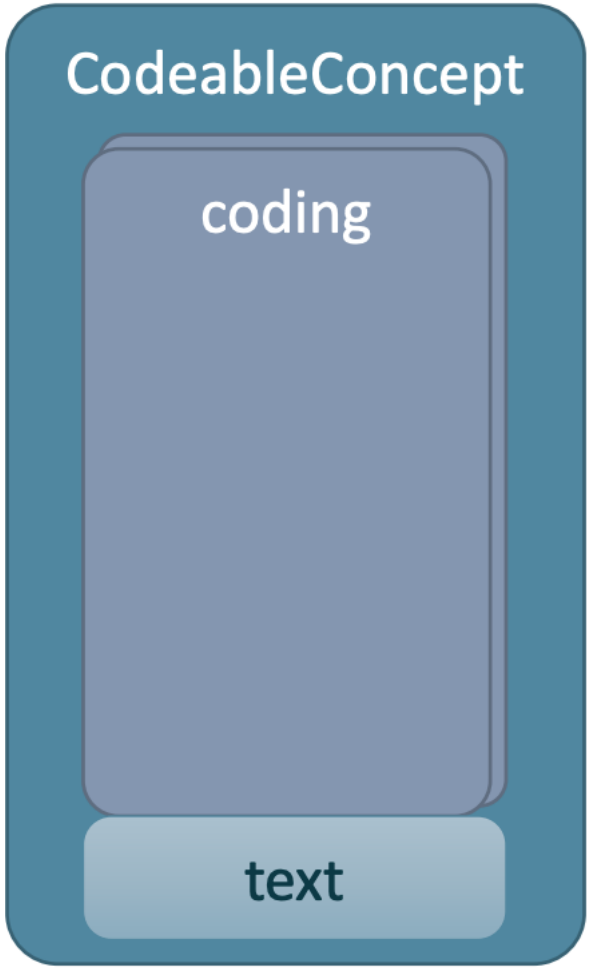
Resources - Bindings

Coded Elements

Code	Coding	CodeableConcept
System é subentendido pelo sistema, apenas usado em elementos ”Core”	Adds information to the code, like system and version	A concept may have diferente codes from diferente systems

[Toothache]

SNOMED: 27355003
MedDRA: 10030090
MESH: D014098



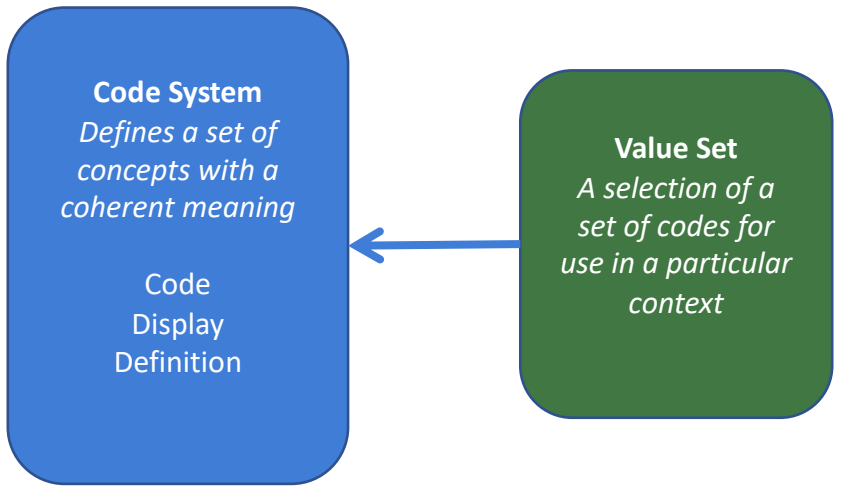
Resources - Bindings

Code System
Defines a set of concepts with a coherent meaning

Code
Display
Definition

- SNOMED CT / LOINC / ICD-10
- RxNorm, NDF-RT, ICPC, ICF, CPT, CVX, NUCC HCPT, ATC, ANZSCO entre outros
- Tables HL7 V2, V3 code systems
- Lists
- *config table*
- Country Codes (ISO 3166)

Resources - Bindings

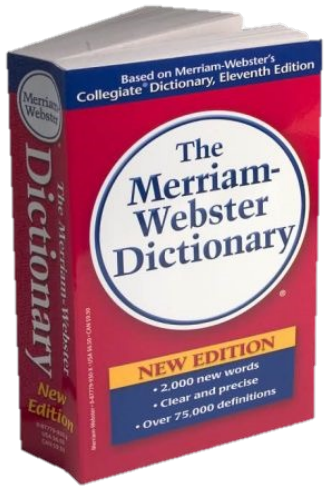


- LOINC Codes that **I use**
- Every LOINC codes for orders
- Intra-hospitals List (exams, medication, etc)
- List of drugs used in a single service
- List of all existente Active principles + “no allergy”

<u>May be confusing!!</u>

Resources - Bindings

Definition of terms



Takes *concepts* from…

"Dante's deadly sins"

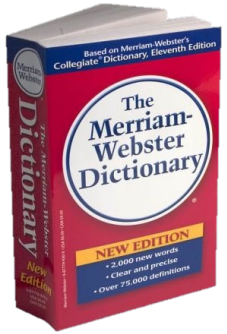
Pride
Envy
Wrath
Sloth
Avarice
Gluttony
Lust

An enumeration of terms

"Code System"
Example: SNOMED-CT

"ValueSet"
Example: "Childhood diseases"

Resources - Bindings

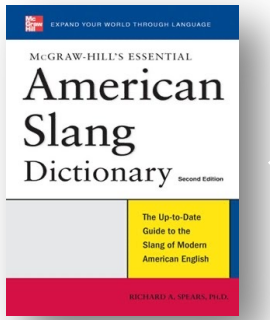


Takes concepts from…

"All words under B"

"All words in the Merriam-Webster dictionary"

Takes concepts from…



Takes concepts from…

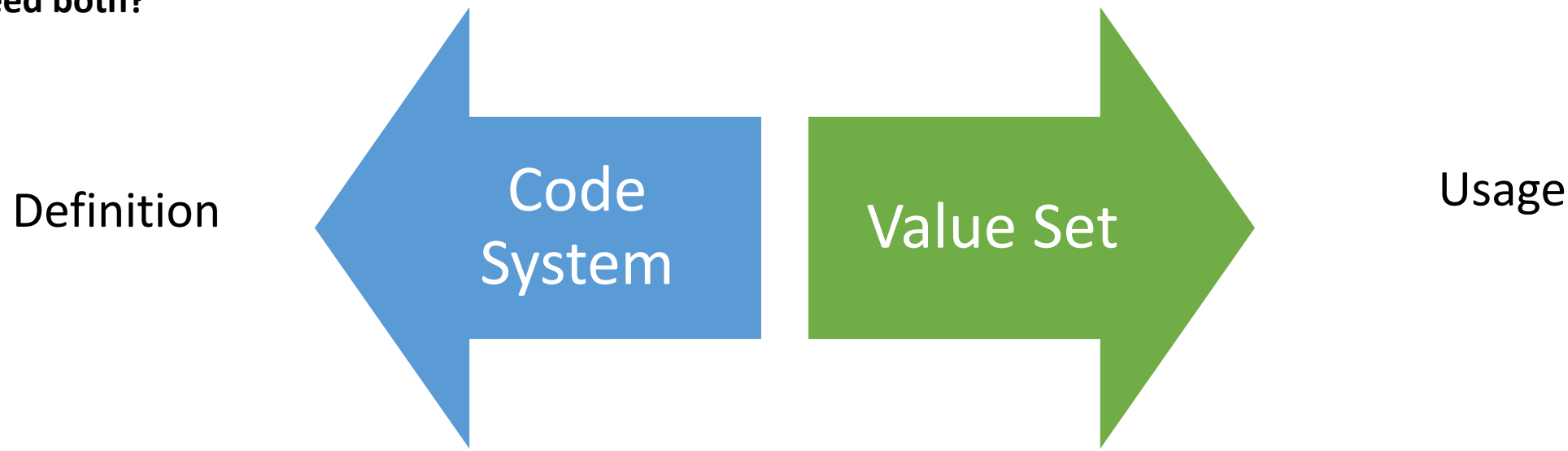
Words for 'nerd'

Bookworm
Geek
Grind
Weenie
Wonk
Dink (slang)
Dork (slang)
Swot (slang)

Can take concepts from multiple coding systems!

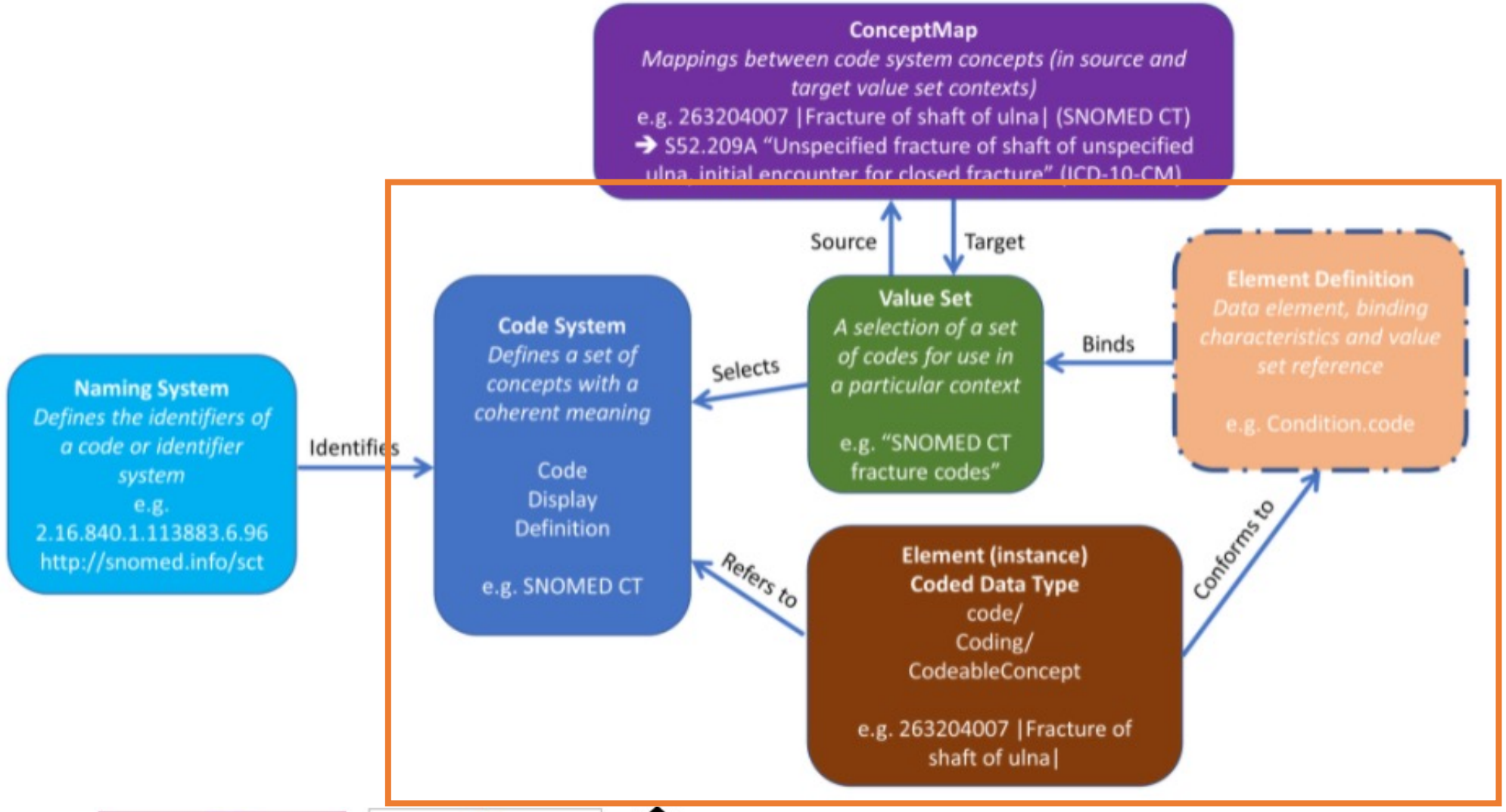
Resources - Bindings

Why we need both?



- **A Value Set may contain all the values from a code System**
- **A Value Set may contain values from different Code Systems**

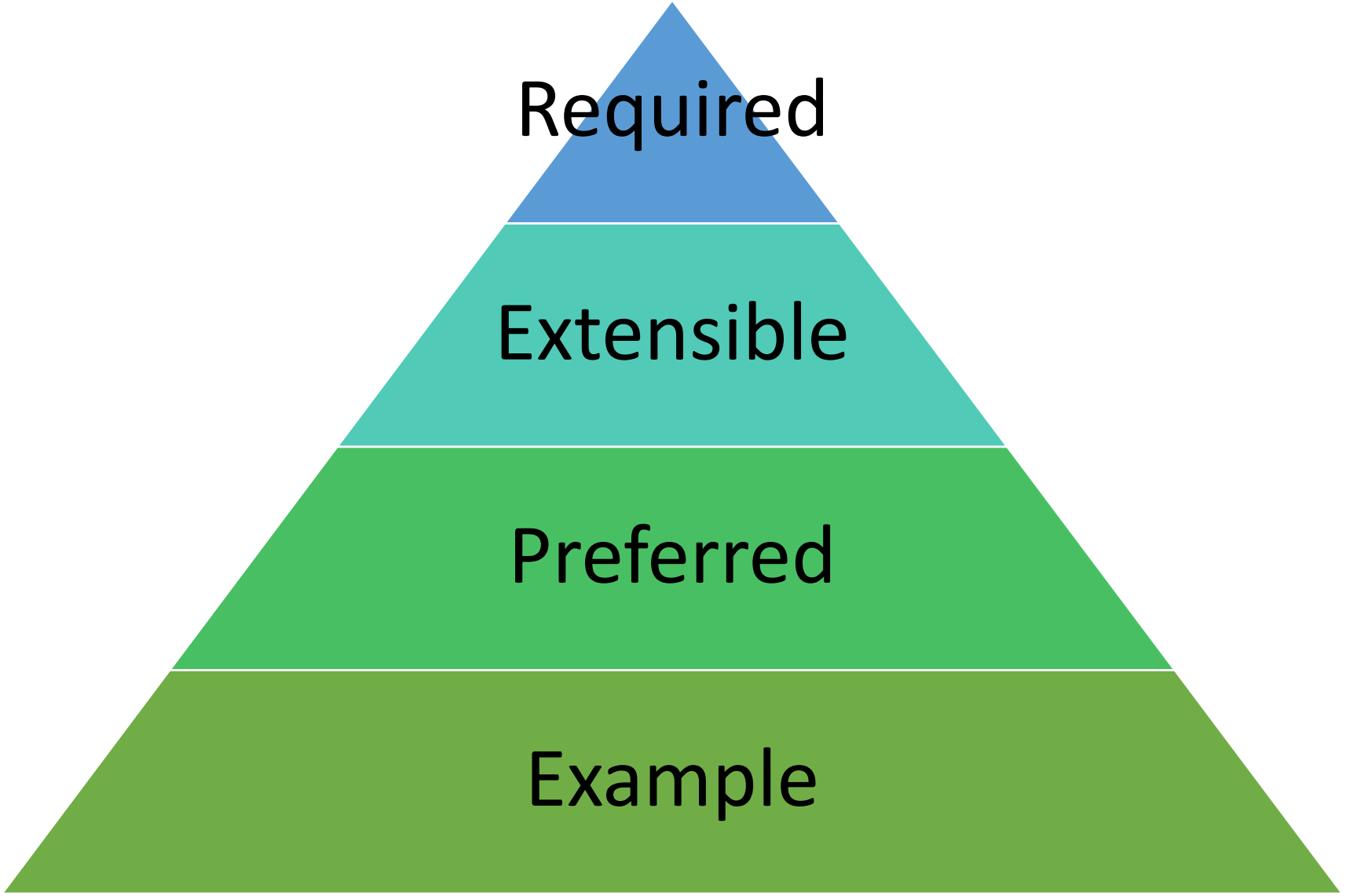
Resources - Bindings



Resources - Bindings

Path	Definition	Type	Reference
Patient.gender Patient.contact.gender	The gender of a person used for administrative purposes.	Required	AdministrativeGender
Patient.maritalStatus	The domestic partnership status of a person.	Extensible	Marital Status Codes
Patient.contact.relationship	The nature of the relationship between a patient and a contact person for that patient.	Extensible	PatientContactRelationship
Patient.communication.language	A human language.	Preferred, but limited to AllLanguages	CommonLanguages
Patient.link.type	The type of link between this patient resource and another patient resource.	Required	LinkType

Resources - Bindings



Resources - Bindings

In practice…

Name	Flags	Card.	Type	Description & Constraints
Observation	N		DomainResource	Measurements and simple assertions *+ Rule: dataAbsentReason SHALL only be present if Observation.value[x] is* *+ Rule: If Observation.code is the same as an Observation.component.code* *element associated with the code SHALL NOT be present* Elements defined in Ancestors: id, meta, implicitRules, language, text, cont modifierExtension
identifier	Σ	0..*	Identifier	Business Identifier for observation
basedOn	Σ	0..*	Reference(CarePlan | DeviceRequest | ImmunizationRecommendation | MedicationRequest | NutritionOrder | ServiceRequest)	Fulfills plan, proposal or order
partOf	Σ	0..*	Reference(MedicationAdministration | MedicationDispense | MedicationStatement | Procedure | Immunization | ImagingStudy)	Part of referenced event
status	?! Σ	1..1	code	registered | preliminary | final | amended + ObservationStatus (Required)
category		0..*	CodeableConcept	Classification of type of observation Observation Category Codes (Preferred)
code	Σ	1..1	CodeableConcept	Type of observation (code / type) LOINC Codes (Example)
subject	Σ	0..1	Reference(Patient | Group | Device | Location | Organization | Procedure | Practitioner | Medication | Substance)	Who and/or what the observation is about
focus	Σ TU	0..*	Reference(Any)	What the observation is about, when it is not about the subject of record
encounter	Σ	0..1	Reference(Encounter)	Healthcare event during which this observation is made
effective[x]	Σ	0..1		Clinically relevant time/time-period for observation
effectiveDateTime			dateTime	
effectivePeriod			Period	
effectiveTiming			Timing	
effect				

This is a value set defined by the FHIR project.

Summary

Defining URL:	http://hl7.org/fhir/ValueSet/observation-status
Version:	4.3.0
Name:	ObservationStatus
Title:	ObservationStatus
Definition:	Codes providing the status of an observation.
Committee:	Orders and Observations Work Group
OID:	2.16.840.1.113883.4.642.3.400 (for OID based terminology systems)
Source Resource	XML / JSON

This value set is used in the following places:

Resources - Bindings

In practice…

A valid and compliant Observation resource can only have 1 out of 8 options for the status

This value set contains 8 concepts

Expansion based on ObservationStatus v4.3.0 (CodeSystem)

All codes in this table are from the system `http://hl7.org/fhir/observation-status`

Level	Code	Display	Definition
1	registered	Registered	The existence of the observation is registered, but there is no result yet available.
1	preliminary	Preliminary	This is an initial or interim observation: data may be incomplete or unverified.
1	final	Final	The observation is complete and there are no further actions needed. Additional information such "released", "signed", etc would be represented using [Provenance](provenance.html) which provides not only the act but also the actors and dates and other related data. These act states would be associated with an observation status of `preliminary` until they are all completed and then a status of `final` would be applied.
1	amended	Amended	Subsequent to being Final, the observation has been modified subsequent. This includes updates/new information and corrections.
2	corrected	Corrected	Subsequent to being Final, the observation has been modified to correct an error in the test result.
1	cancelled	Cancelled	The observation is unavailable because the measurement was not started or not completed (also sometimes called "aborted").
1	entered-in-error	Entered in Error	The observation has been withdrawn following previous final release. This electronic record should never have existed, though it is possible that real-world decisions were based on it. (If real-world activity has occurred, the status should be "cancelled" rather than "entered-in-error".).
1	unknown	Unknown	The authoring/source system does not know which of the status values currently applies for this observation. Note: This concept is not to be used for "other" - one of the listed statuses is presumed to apply, but the authoring/source system does not know which.

Resources - Constraints

id	Level	Location	Description	Expression
pat-1	Rule	Patient.contact	SHALL at least contain a contact's details or a reference to an organization	name.exists() or telecom.exists() or address.exists() or organization.exists()

id	Level	Location	Description	Expression
obs-3	Rule	Observation.referenceRange	Must have at least a low or a high or text	low.exists() or high.exists() or text.exists()
obs-6	Rule	(base)	dataAbsentReason SHALL only be present if Observation.value[x] is not present	dataAbsentReason.empty() or value.empty()
obs-7	Rule	(base)	If Observation.code is the same as an Observation.component.code then the value element associated with the code SHALL NOT be present	value.empty() or component.code.where(coding.intersect(%resource.code.coding).exists()).empty()

Resources - Constraints

id	Level	Location	Description	Expression
pat-1	Rule	Patient.contact	SHALL at least contain a contact's details or a reference to an organization	name.exists() or telecom.exists() or address.exists() or organization.exists()

contact	I	0..*	BackboneElement	A contact party (e.g. guardian, partner, friend) for the patient *+ Rule: SHALL at least contain a contact's details or a reference to an organization*
relationship		0..*	CodeableConcept	The kind of relationship Patient Contact Relationship (Extensible)
name		0..1	HumanName	A name associated with the contact person
telecom		0..*	ContactPoint	A contact detail for the person
address		0..1	Address	Address for the contact person
gender		0..1	code	male | female | other | unknown AdministrativeGender (Required)
organization	I	0..1	Reference(Organization)	Organization that is associated with the contact
period		0..1	Period	The period during which this contact person or organization is valid to be contacted relating to this patient

Resources - Constraints

id	Level	Location	Description	Expression
obs-3	Rule	Observation.referenceRange	Must have at least a low or a high or text	low.exists() or high.exists() or text.exists()

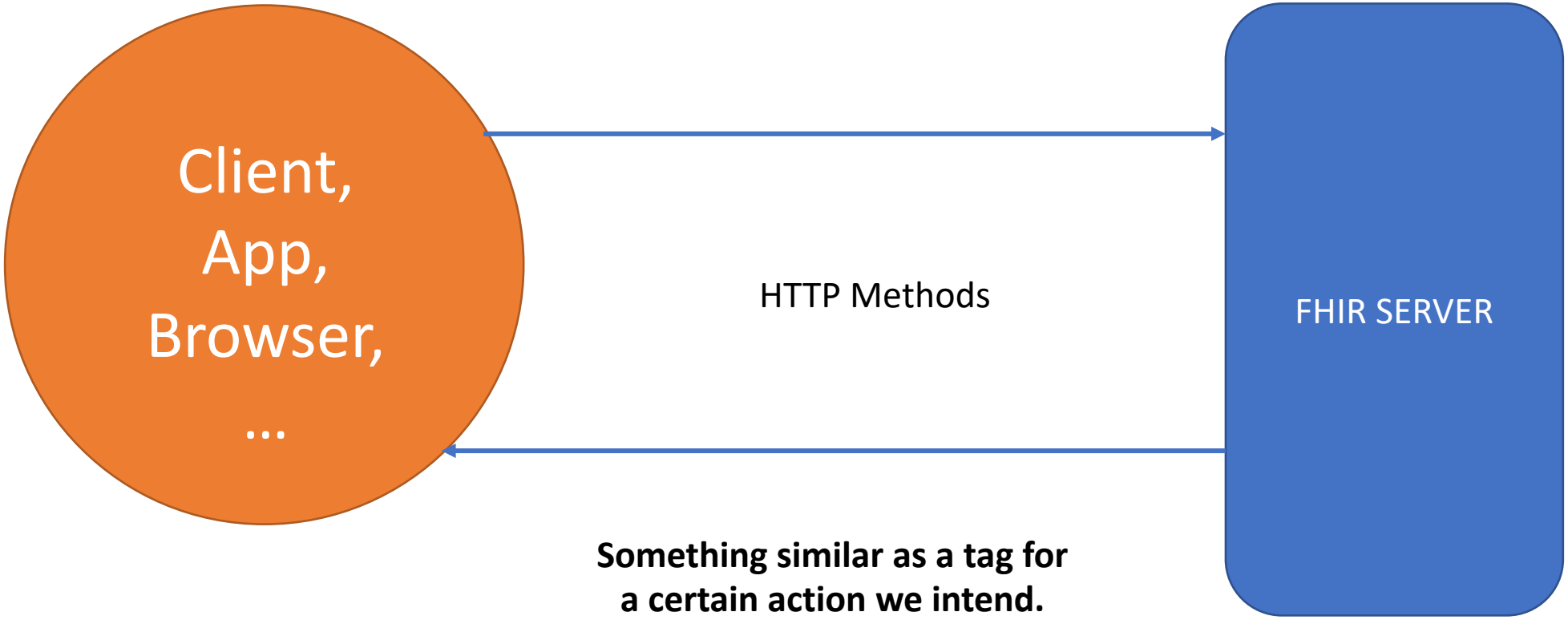
referenceRange	I	0..*	BackboneElement	Provides guide for interpretation *+ Rule: Must have at least a low or a high or text*
low	I	0..1	SimpleQuantity	Low Range, if relevant
high	I	0..1	SimpleQuantity	High Range, if relevant
type		0..1	CodeableConcept	Reference range qualifier Observation Reference Range Meaning Codes (Preferred)
appliesTo		0..*	CodeableConcept	Reference range population Observation Reference Range Applies To Codes (Example)
age		0..1	Range	Applicable age range, if relevant
text		0..1	string	Text based reference range in an observation

Resources – Search Parameters

Name	Type	Description	Expression	In Common
active TU	token	Whether the patient record is active	Patient.active	
address TU	string	A server defined search that may match any of the string fields in the Address, including line, city, district, state, country, postalCode, and/or text	Patient.address	3 Resources
address-city TU	string	A city specified in an address	Patient.address.city	3 Resources
address-country TU	string	A country specified in an address	Patient.address.country	3 Resources
address-postalcode TU	string	A postalCode specified in an address	Patient.address.postalCode	3 Resources
address-state TU	string	A state specified in an address	Patient.address.state	3 Resources
address-use TU	token	A use code specified in an address	Patient.address.use	3 Resources
birthdate TU	date	The patient's date of birth	Patient.birthDate	2 Resources
death-date TU	date	The date of death has been provided and satisfies this search value	(Patient.deceased as dateTime)	
deceased TU	token	This patient has been marked as deceased, or as a death date entered	Patient.deceased.exists() and Patient.deceased != false	
email TU	token	A value in an email contact	Patient.telecom.where(system='email')	4 Resources
family TU	string	A portion of the family name of the patient	Patient.name.family	1 Resources
gender TU	token	Gender of the patient	Patient.gender	3 Resources
general-practitioner TU	reference	Patient's nominated general practitioner, not the organization that manages the record	Patient.generalPractitioner (Practitioner, Organization, PractitionerRole)	
given TU	string	A portion of the given name of the patient	Patient.name.given	1 Resources
identifier TU	token	A patient identifier	Patient.identifier	
language TU	token	Language code (irrespective of use value)	Patient.communication.language	
link TU	reference	All patients linked to the given patient	Patient.link.other (Patient, RelatedPerson)	
name TU	string	A server defined search that may match any of the string fields in the HumanName, including family, give, prefix, suffix, suffix, and/or text	Patient.name	
organization TU	reference	The organization that is the custodian of the patient record	Patient.managingOrganization (Organization)	
phone TU	token	A value in a phone contact	Patient.telecom.where(system='phone')	4 Resources
phonetic TU	string	A portion of either family or given name using some kind of phonetic matching algorithm	Patient.name	3 Resources
				4 Resources

Resources – Search Parameters

Understanding searches…

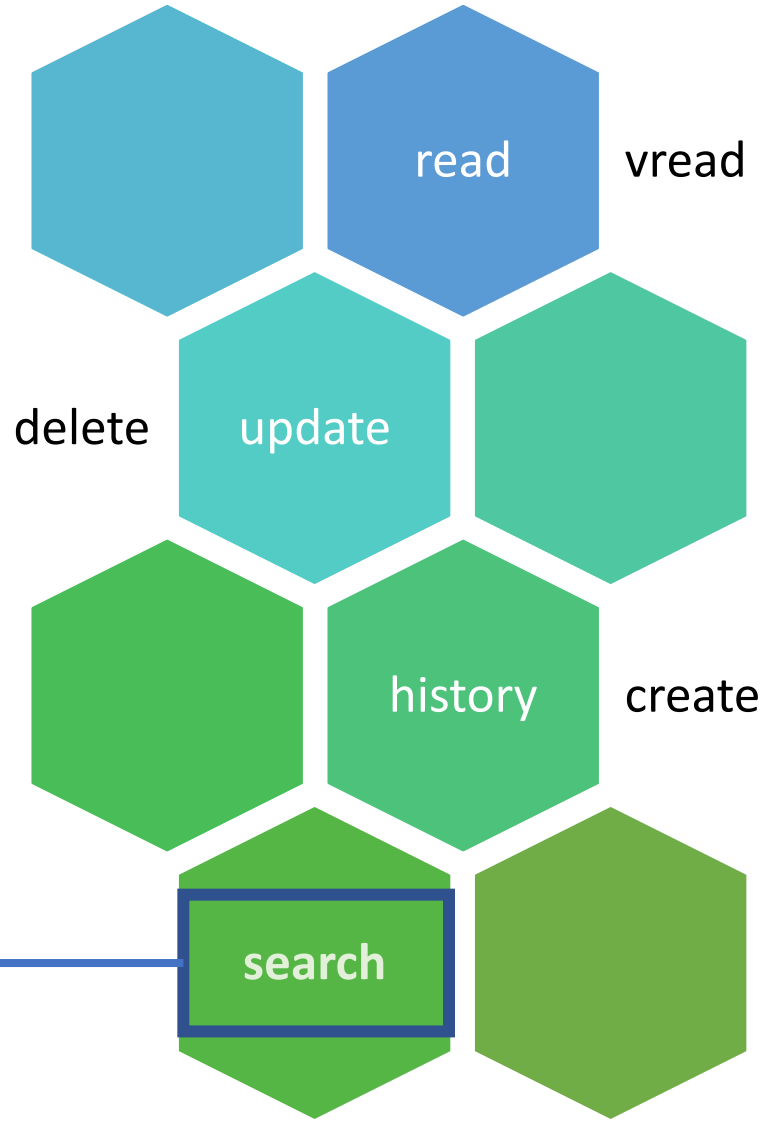


Something similar as a tag for a certain action we intend.

Resources – Search Parameters

Understanding searches…

Common HTTP methods are GET, POST, PUT, and DELETE.



Resources – Search Parameters

Understanding searches…

<URL>/<Resource>?<Parameter>

https://vonk.fire.ly/r4/Patient
https://vonk.fire.ly/r4/Patient?_count=10
https://vonk.fire.ly/r4/Patient?_count=10&_sort=-_lastUpdated
https://vonk.fire.ly/r4/Patient?identifier=http://www.miniaf.alp/citreg|1020304050

Resources – Search Parameters

https://vonk.fire.ly/r4/Patient

Gets all Patients from this server

https://vonk.fire.ly/r4/Patient?_count=10

Gets all patients from the server but only returns 10

https://vonk.fire.ly/r4/Patient?_count=10&_sort=-_lastUpdated

Gets all patients from the server but only returns 10 and orders them by the last updated

https://vonk.fire.ly/r4/Patient?identifier=http://www.miniaf.alp/citreg|1020304050

Gets all patients from the server which matches a certain identifier

Resources – Search Parameters

Search is very flexible, which means it can also become very complex

eq	the value for the parameter in the resource is equal to the provided value
ne	the value for the parameter in the resource is not equal to the provided value
gt	the value for the parameter in the resource is greater than the provided value
lt	the value for the parameter in the resource is less than the provided value
ge	the value for the parameter in the resource is greater or equal to the provided value
le	the value for the parameter in the resource is less or equal to the provided value
sa	the value for the parameter in the resource starts after the provided value
eb	the value for the parameter in the resource ends before the provided value
ap	the value for the parameter in the resource is approximately the same to the provided value. Note that the recommended value for the approximation is 10% of the stated value (or for a date, 10% of the gap between now and the date), but systems may choose other values where appropriate

Resources – Search Parameters

Name	Type	Description	Expression	In Common
active TU	token	Whether the patient record is active	Patient.active	
address TU	string	A server defined search that may match any of the string fields in the Address, including line, city, district, state, country, postalCode, and/or text	Patient.address	3 Resources
address-city TU	string	A city specified in an address	Patient.address.city	3 Resources
address-country TU	string	A country specified in an address	Patient.address.country	3 Resources
address-postalcode TU	string	A postalCode specified in an address	Patient.address.postalCode	3 Resources
address-state TU	string	A state specified in an address	Patient.address.state	3 Resources
address-use TU	token	A use code specified in an address	Patient.address.use	3 Resources
birthdate TU	date	The patient's date of birth	Patient.birthDate	2 Resources
death-date TU	date	The date of death has been provided and satisfies this search value	(Patient.deceased as dateTime)	
deceased TU	token	This patient has been marked as deceased, or as a death date entered	Patient.deceased.exists() and Patient.deceased != false	
email TU	token	A value in an email contact	Patient.telecom.where(system='email')	4 Resources
family TU	string	A portion of the family name of the patient	Patient.name.family	1 Resources
gender TU	token	Gender of the patient	Patient.gender	3 Resources
general-practitioner TU	reference	Patient's nominated general practitioner, not the organization that manages the record	Patient.generalPractitioner (Practitioner, Organization, PractitionerRole)	
given TU	string	A portion of the given name of the patient	Patient.name.given	1 Resources
identifier TU	token	A patient identifier	Patient.identifier	
language TU	token	Language code (irrespective of use value)	Patient.communication.language	
link TU	reference	All patients linked to the given patient	Patient.link.other (Patient, RelatedPerson)	
name TU	string	A server defined search that may match any of the string fields in the HumanName, including family, give, prefix, suffix, suffix, and/or text	Patient.name	
organization TU	reference	The organization that is the custodian of the patient record	Patient.managingOrganization (Organization)	
phone TU	token	A value in a phone contact	Patient.telecom.where(system='phone')	4 Resources
phonetic TU	string	A portion of either family or given name using some kind of phonetic matching	Patient.name	3 Resources
telec				4 Resources

This table, taken from the website, shows the attributes that we must be able to search in a server.

Which means, that a compliant FHIR server must support these searches for the Patient Resource.

Every resource has a similar table

Exercise

Regarding Observation resource

- What is the terminology proposed for Observation.code?
- Which is a possible value for Observation.bodySite?

Regarding procedure resource

- What is the scope?

Regarding patient resource

- One search parameter

10.1.4 Resource Content

Structure | UML | XML | JSON | Turtle | R4 Diff | All

Structure

Name	Flags	Card.	Type	Description & Constraints
Observation	N		DomainResource	Measurements and simple assertions *+ Rule: dataAbsentReason SHALL only be present if Observation.value[x] is not present* *+ Rule: If Observation.code is the same as an Observation.component.code then the value element associated with the code SHALL NOT be present* Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	Business Identifier for observation
basedOn	Σ	0..*	Reference(CarePlan | DeviceRequest | ImmunizationRecommendation | MedicationRequest | NutritionOrder | ServiceRequest)	Fulfills plan, proposal or order
partOf	Σ	0..*	Reference(MedicationAdministration | MedicationDispense | MedicationStatement | Procedure | Immunization | ImagingStudy)	Part of referenced event
status	?! Σ	1..1	code	registered | preliminary | final | amended + ObservationStatus (Required)
category		0..*	CodeableConcept	Classification of type of observation ~~Observation Category Codes (Preferred)~~
code	Σ	1..1	CodeableConcept	Type of observation (code / type) LOINC Codes (Example)
subject	Σ	0..1	Reference(Patient | Group | Device | Location | Organization | Procedure | Practitioner | Medication | Substance)	Who and/or what the observation is about
focus	Σ TU	0..*	Reference(Any)	What the observation is about, when it is not about the subject of record
encounter	Σ	0..1	Reference(Encounter)	Healthcare event during which this observation is made
effective[x]	Σ	0..1		Clinically relevant time/time-period for observation
effectiveDateTime			dateTime	
effectivePeriod			Period	
effectiveTiming			Timing	
effectiveInstant			instant	
issued	Σ	0..1	instant	Date/Time this version was made available

			RelatedPerson)	
value[x]	Σ I	0..1		Actual result
valueQuantity			Quantity	
valueCodeableConcept			CodeableConcept	
valueString			string	
valueBoolean			boolean	
valueInteger			integer	
valueRange			Range	
valueRatio			Ratio	
valueSampledData			SampledData	
valueTime			time	
valueDateTime			dateTime	
valuePeriod			Period	
dataAbsentReason	I	0..1	CodeableConcept	Why the result is missing DataAbsentReason (Extensible)
interpretation		0..*	CodeableConcept	High, low, normal, etc. Observation Interpretation Codes (Extensible)
note		0..*	Annotation	Comments about the observation
bodySite		0..1	CodeableConcept	Observed body part SNOMED CT Body Structures (Example)

click

4.4.1.371.2 Expansion

This expansion generated 28 May 2022

This value set has >1000 codes in it. In order to keep the publication size manageable, only a selection (1000 codes) of the whole set of codes is shown

Expansion based on SNOMED CT International edition 31-Jul 2020

All codes in this table are from the system `http://snomed.info/sct`

Code	Display
442083009	Anatomical or acquired body structure (body structure)
106004	Posterior carpal region
107008	Fetal part of placenta
108003	Entire condylar emissary vein
110001	Visceral layer of Bowman's capsule
111002	Parathyroid gland
116007	Subcutaneous tissue of medial surface of index finger
124002	Coronoid process of mandible
149003	Central pair of microtubules, cilium or flagellum, not bacterial
155008	Deep circumflex artery of ilium
167005	Supraclavicular part of brachial plexus
202009	Anterior division of renal artery
205006	Entire left commissure of aortic valve
206007	Gluteus maximus muscle
221001	Articular surface, phalanges, of fourth metacarpal bone
227002	Canal of Hering

9.3 Resource Procedure - Content

Patient Care Work Group	Maturity Level: 3	Trial Use	Security Category: Patient	Compartments: Encounter, Patient, Practitioner, RelatedPerson

An action that is or was performed on or for a patient. This can be a physical intervention like an operation, or less invasive like long term services, counseling, or hypnotherapy.

9.3.1 Scope and Usage

Procedure is one of the event resources in the FHIR workflow specification.

This resource is used to record the details of current and historical procedures performed on or for a patient. A procedure is an activity that is performed on, with, or for a patient as part of the provision of care. Examples include surgical procedures, diagnostic procedures, endoscopic procedures, biopsies, counseling, physiotherapy, personal support services, adult day care services, non-emergency transportation, home modification, exercise, etc. Procedures may be performed by a healthcare professional, a service provider, a friend or relative or in some cases by the patient themselves.

This resource provides summary information about the occurrence of the procedure and is not intended to provide real-time snapshots of a procedure as it unfolds, though for long-running procedures such as psychotherapy, it could represent summary level information about overall progress. The creation of a resource to support detailed real-time procedure information awaits the identification of a specific implementation use-case to share such information.

8.1.13 Search Parameters

Search parameters for this resource. The common parameters also apply. See Searching for more information about searching in REST, messaging, and services.

Name	Type	Description	Expression	In Common
active TU	token	Whether the patient record is active	Patient.active	
address TU	string	A server defined search that may match any of the string fields in the Address, including line, city, district, state, country, postalCode, and/or text	Patient.address	
address-city TU	string	A city specified in an address	Patient.address.city	
address-country TU	string	A country specified in an address	Patient.address.country	
address-postalcode TU	string	A postalCode specified in an address	Patient.address.postalCode	
address-state TU	string	A state specified in an address	Patient.address.state	
address-use TU	token	A use code specified in an address	Patient.address.use	
birthdate TU	date	The patient's date of birth	Patient.birthDate	
death-date TU	date	The date of death has been provided and satisfies this search value	(Patient.deceased as dateTime)	
deceased TU	token	This patient has been marked as deceased, or has a death date entered	Patient.deceased.exists() and Patient.deceased != false	
email TU	token	A value in an email contact	Patient.telecom.where(system='email')	
family TU	string	A portion of the family name of the patient	Patient.name.family	
gender TU	token	Gender of the patient	Patient.gender	

Special Resources

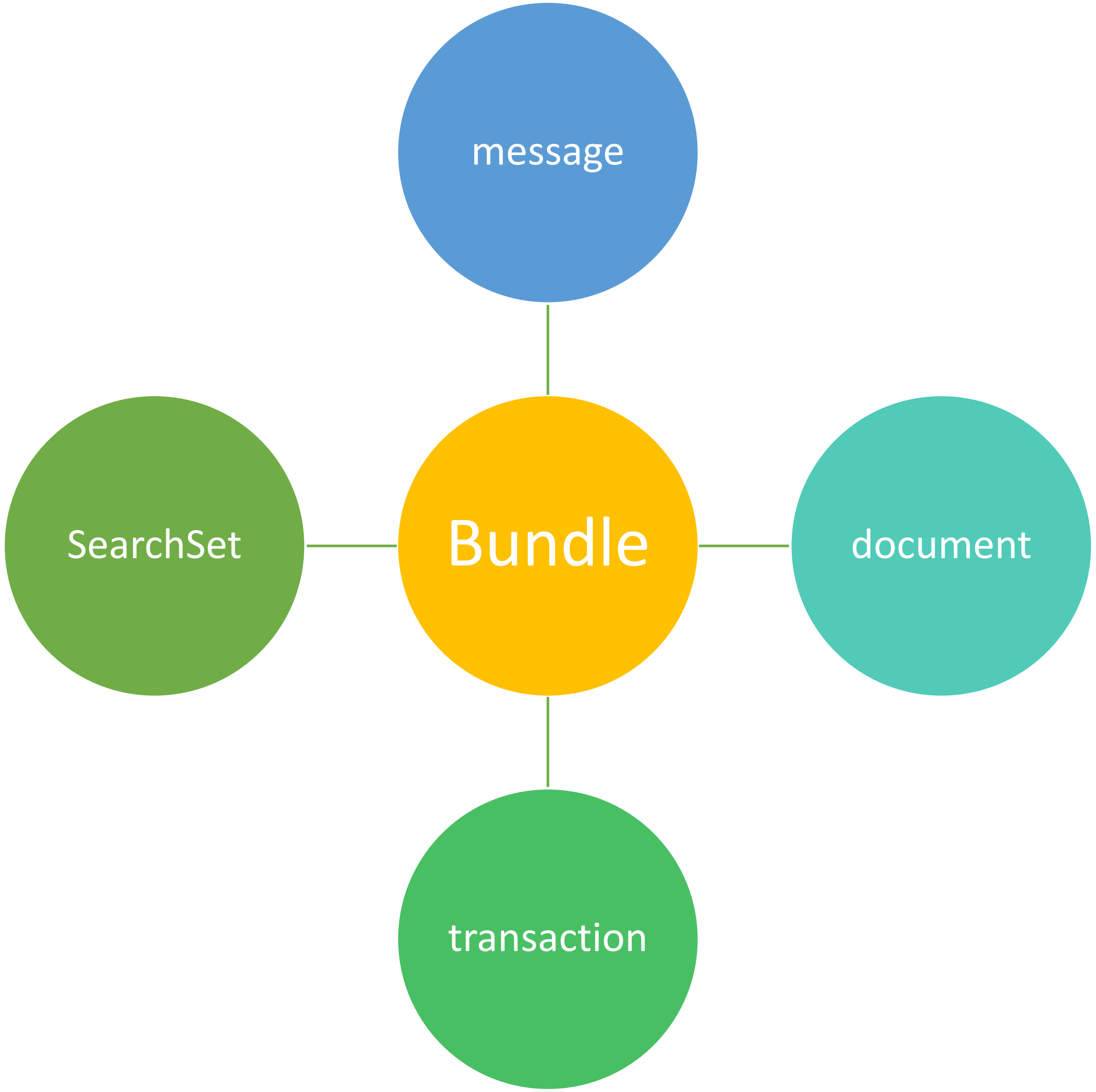
Bundle

Getting things together

Questionnaire

Answering questions

Special Resources



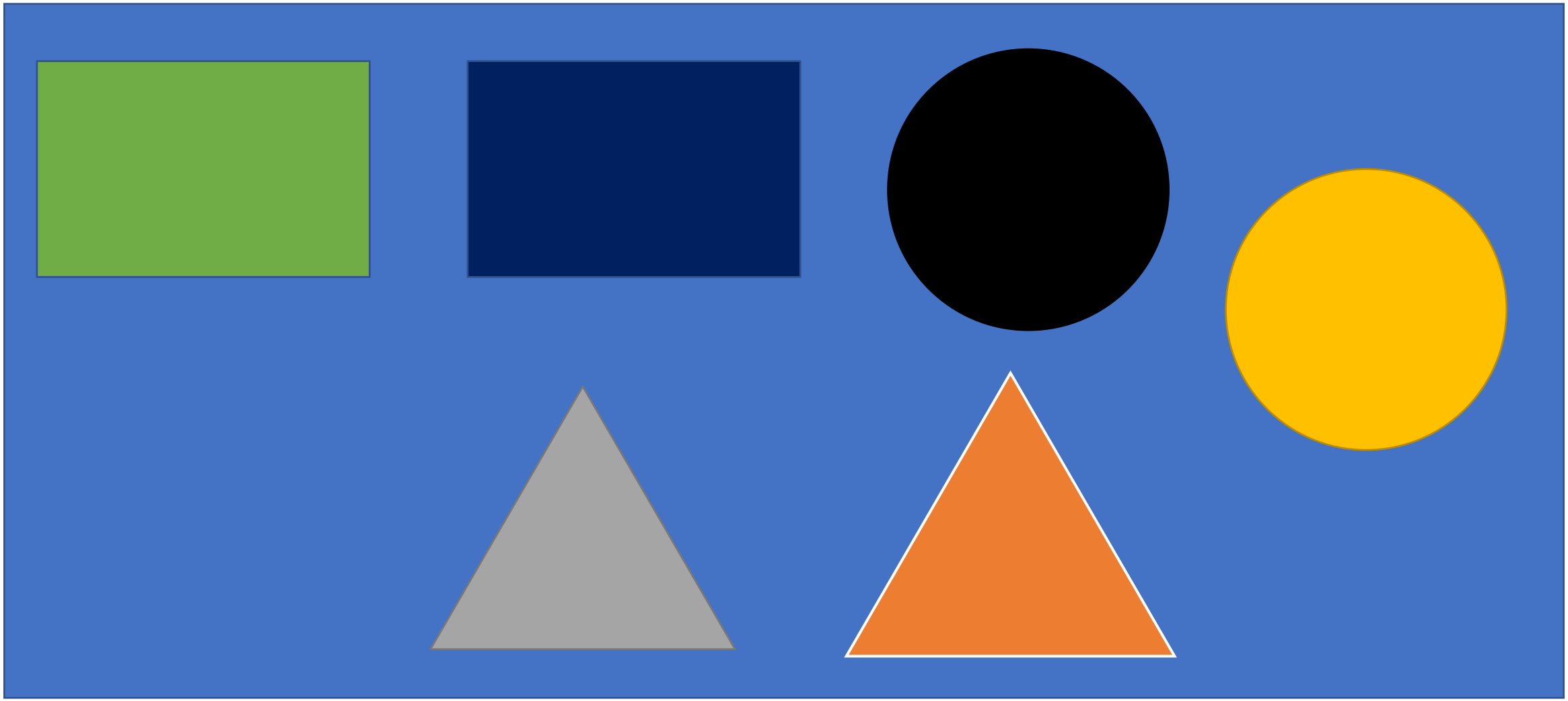
Defined by type (attribute)

Conditionally defined by it:

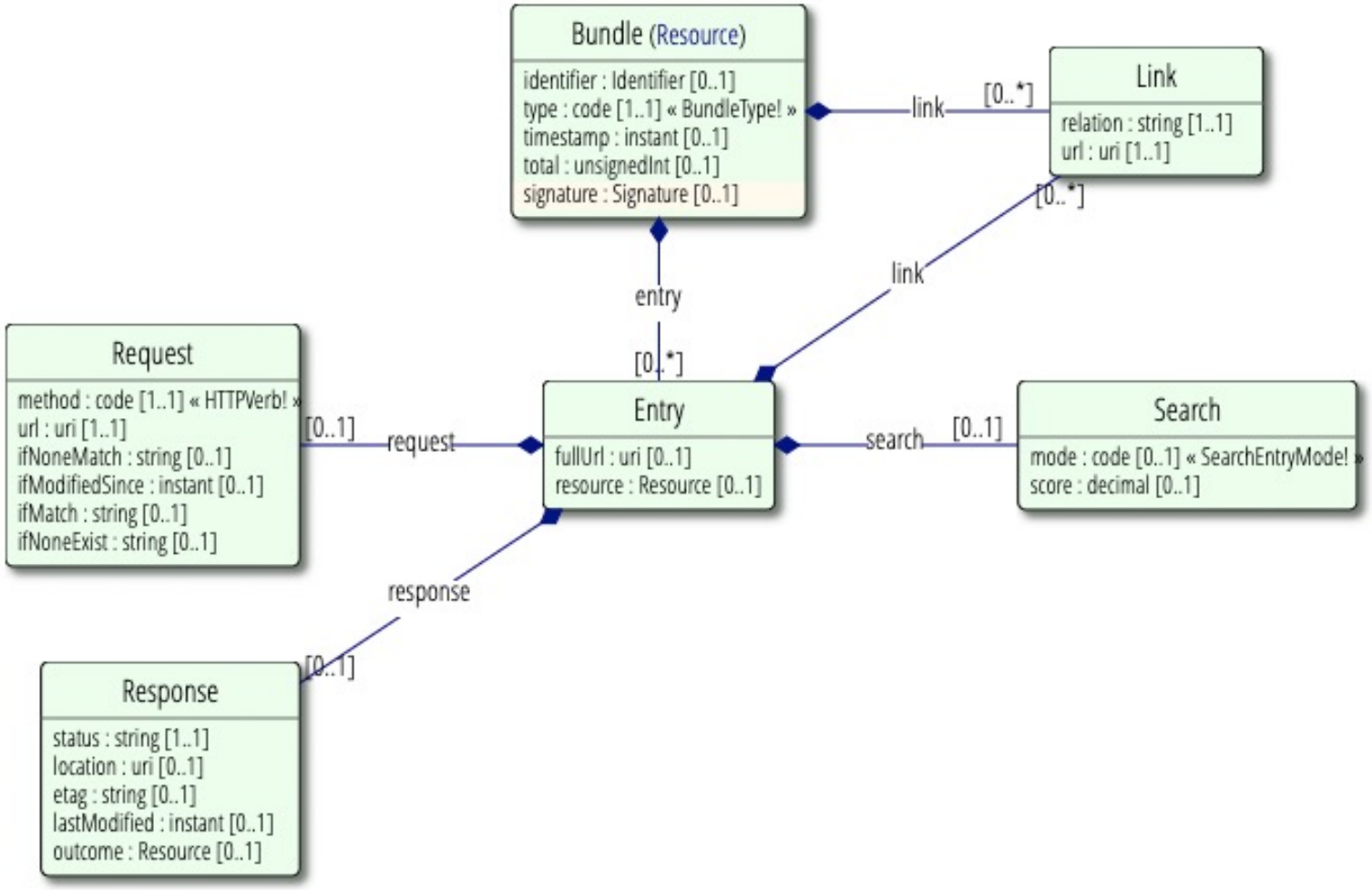
- Message has a certain structures
- Document another
- So on so on

https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

Special Resources



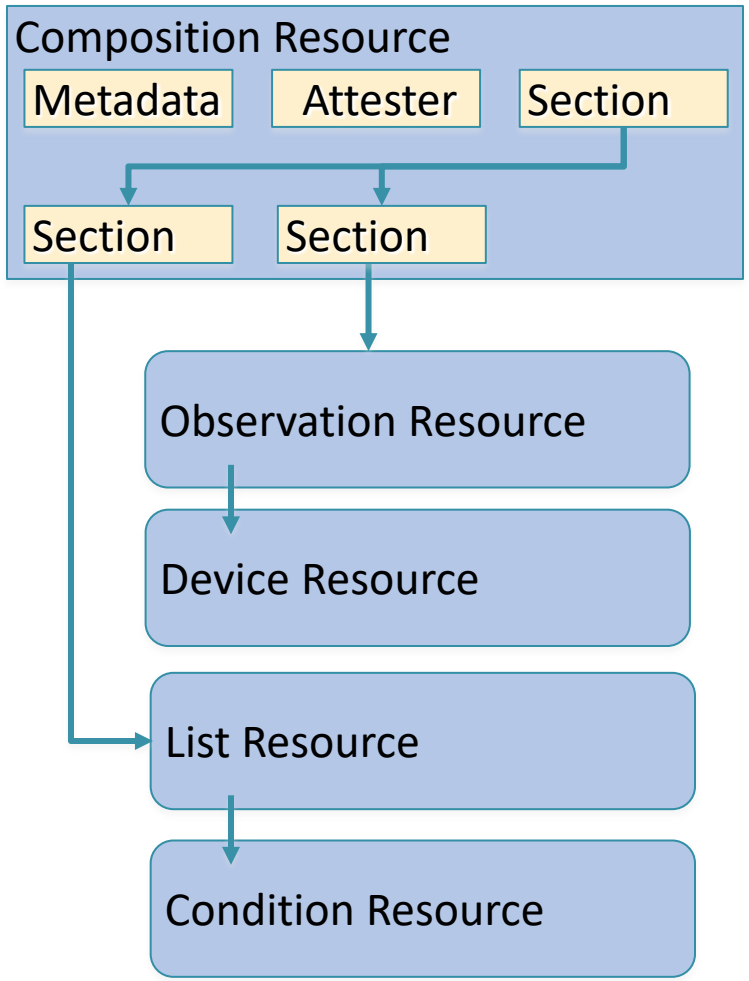
Special Resources



https://github.com/.../.../documents/.../master/presentations/...%20Overview.pptx

Special Resources

DOCUMENT




```
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    <resource>
      <Composition />
    </resource>
  </entry>
  <entry>
    <resource>
      <Observation />
    </resource>
  </entry>
  <entry>
    <resource>
      <Device />
    </resource>
  </entry>
  <entry>
    <resource>
      <List/>
    </resource>
  </entry>
  <entry>
    <resource>
      <Condition/>
    <resource>
  </entry>
</Bundle>
```
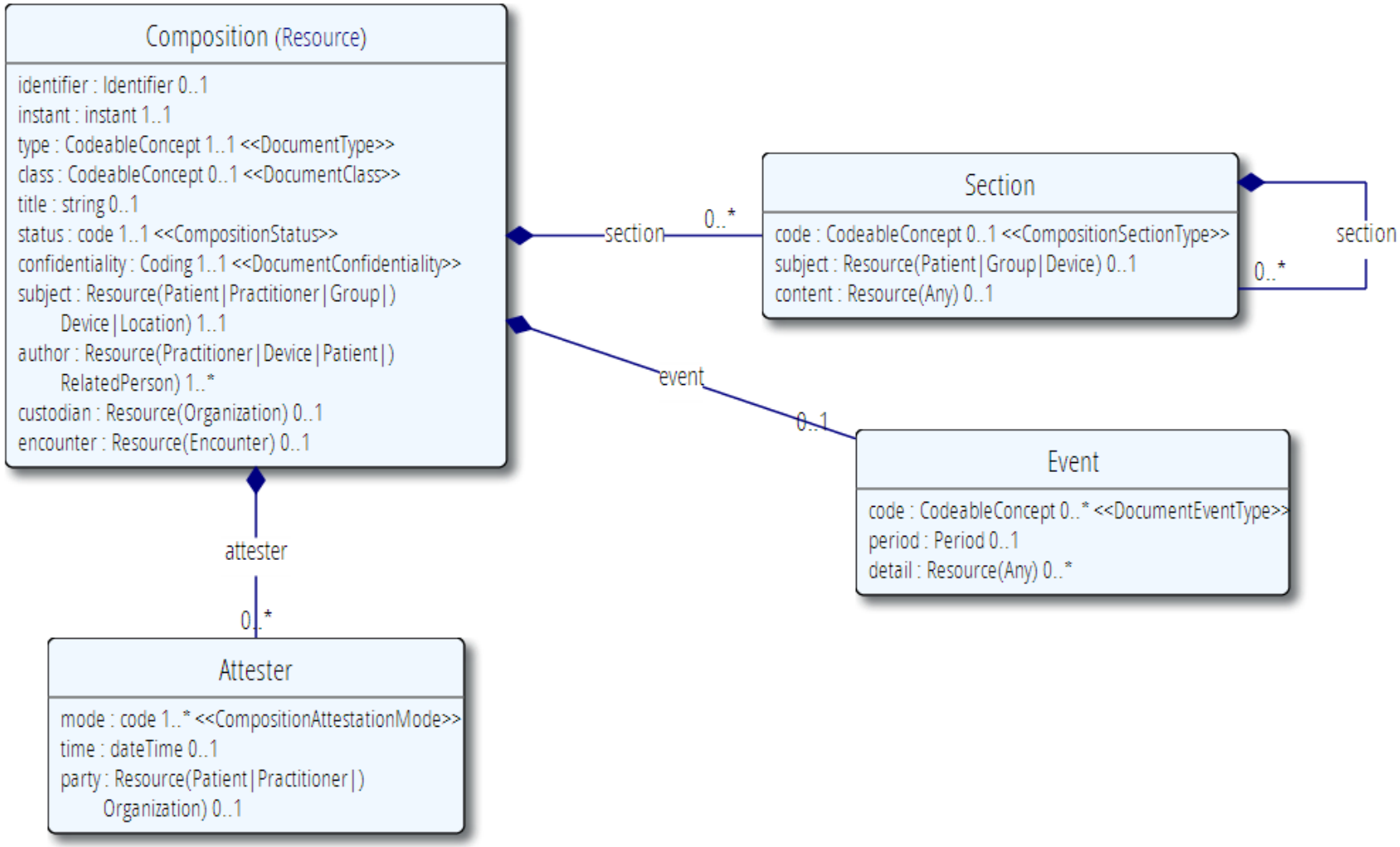

Special Resources

DOCUMENT

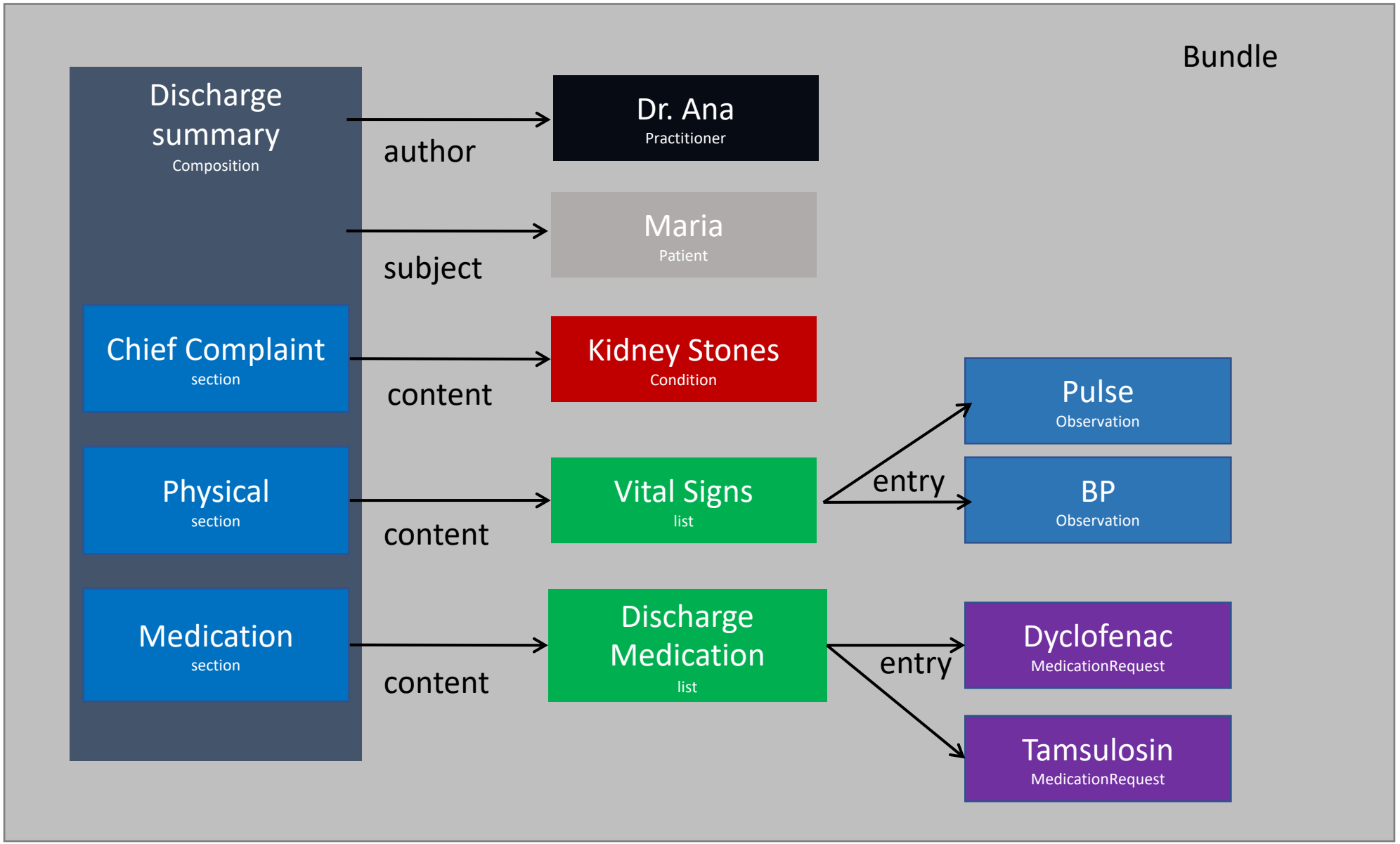
Composition resource must be the first element of a Bundle of type document – acts as index



https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

Special Resources

DOCUMENT



https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

Special Resources

MESSAGE

Similar to v2
- messaging each other

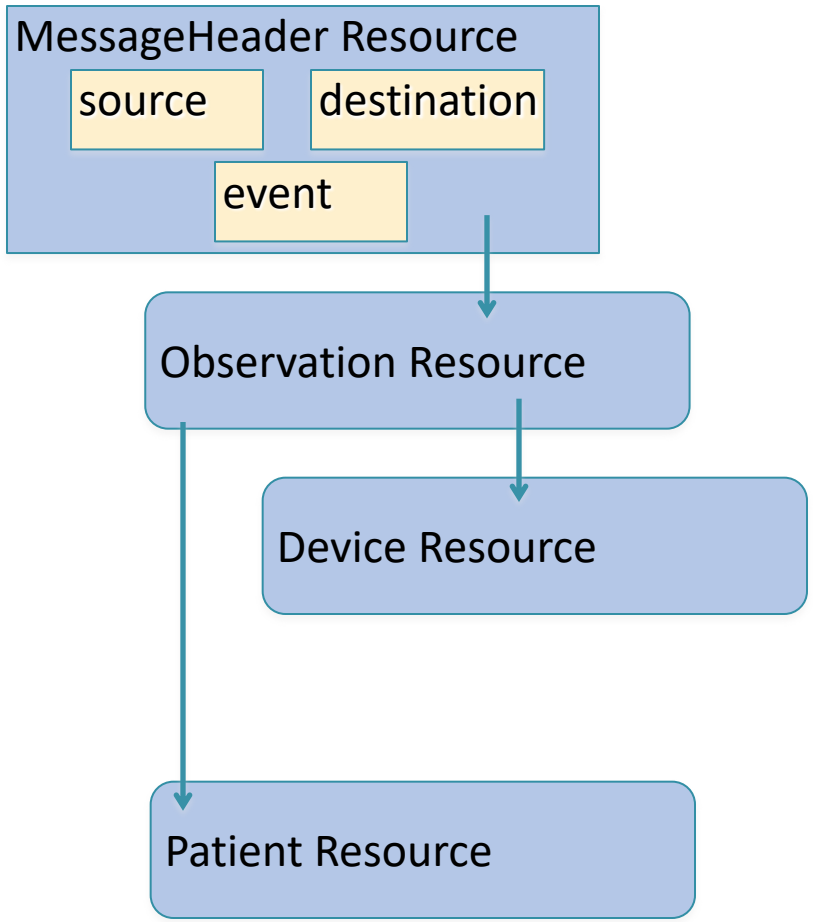
Bundle as well
- MessageHeader on root

Event-driven
- order-result logic
- asynchronous

https://github.co

Special Resources

MESSAGE




```
<Bundle>
  <entry>
    <resource>
      <MessageHeader />
    </resource>
  </entry>
  <entry>
    <resource>
      <Observation />
    </resource>
  </entry>
  <entry>
    <resource>
      <Device />
    </resource>
  </entry>
  <entry>
    <resource>
      <Patient/>
    </resource>
  </entry>
</Bundle>
```

Special Resources

Assessments (Primary Care)
Assessments (consumer)
Patient Reported Outcomes Measures (PROMs)
Case Report Forms
Governmental /Statutory forms
Referrals template
Pre-determination/Claims Forms
…

Special Resources

- Assessments (Primary Care)
- Assessments (consumer)
- Patient Reported Outcomes Measure
- Case Report Forms
- Governmental /Statutory forms
- Referrals template
- Pre-determination/Claims Forms
- …

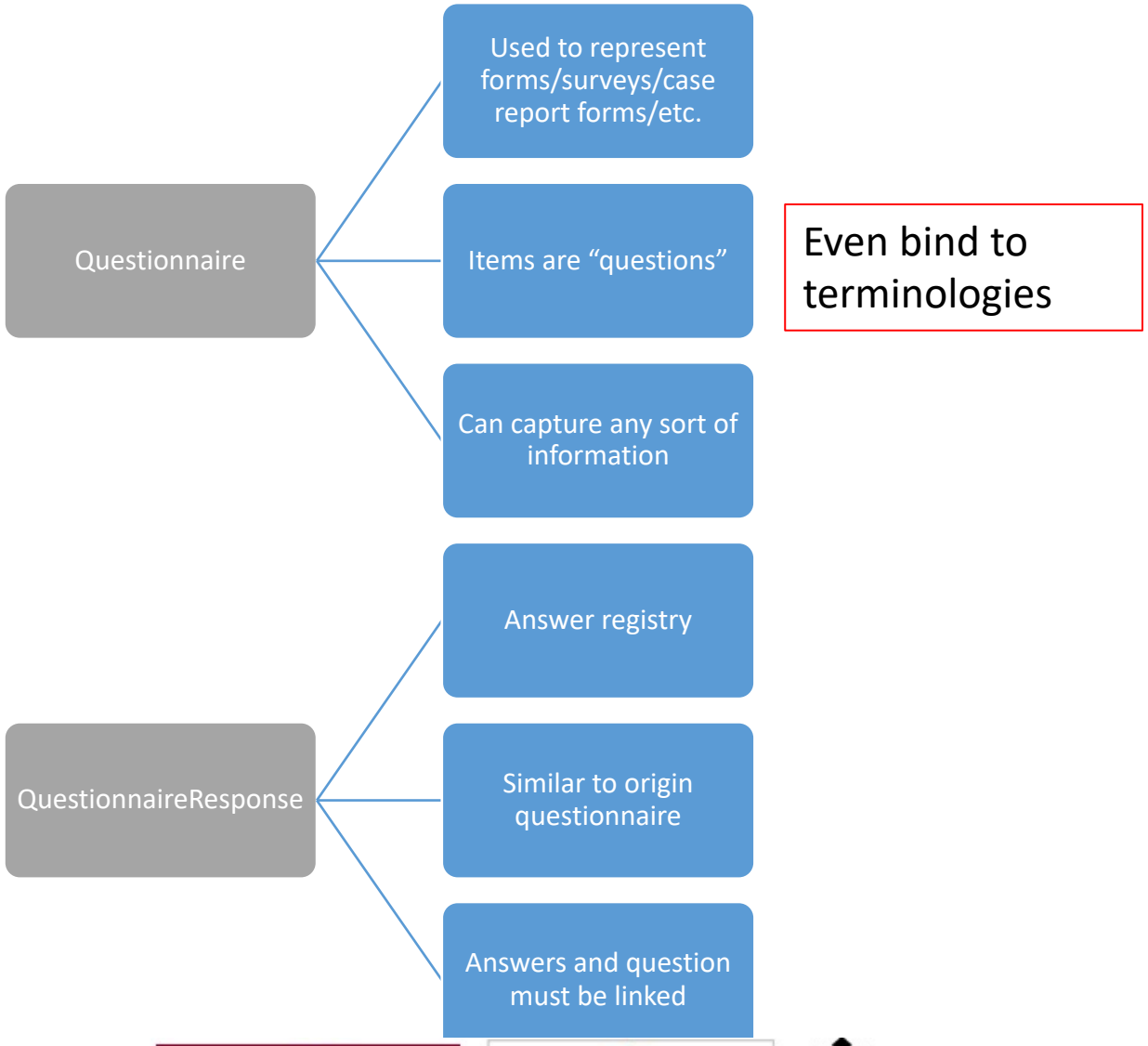
- Condition
- Encounter
- Patient
- Observation
- Claim
- MedicationStatement
- AllergyIntolerance
- Coverage
- Goal
- CarePlan
- …

Special Resources

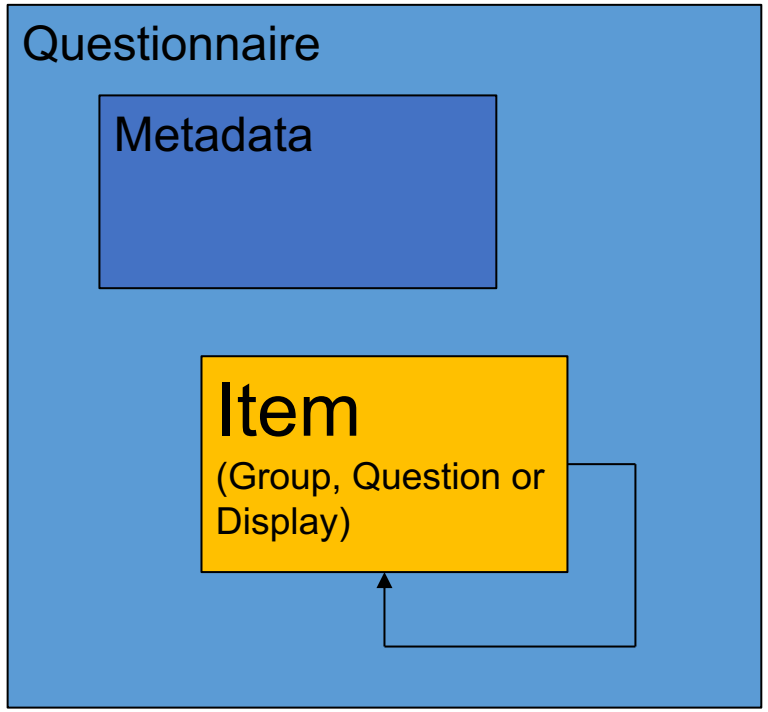
Assessments (Primary Care)	
Assessments (consumer)	
Patient Reported Outcomes Measures (PROMs)	• Questionnaire • QuestionnaireResponse
Case Report Forms	
Governmental /Statutory forms	
Referrals template	
Pre-determination/Claims Forms	

...

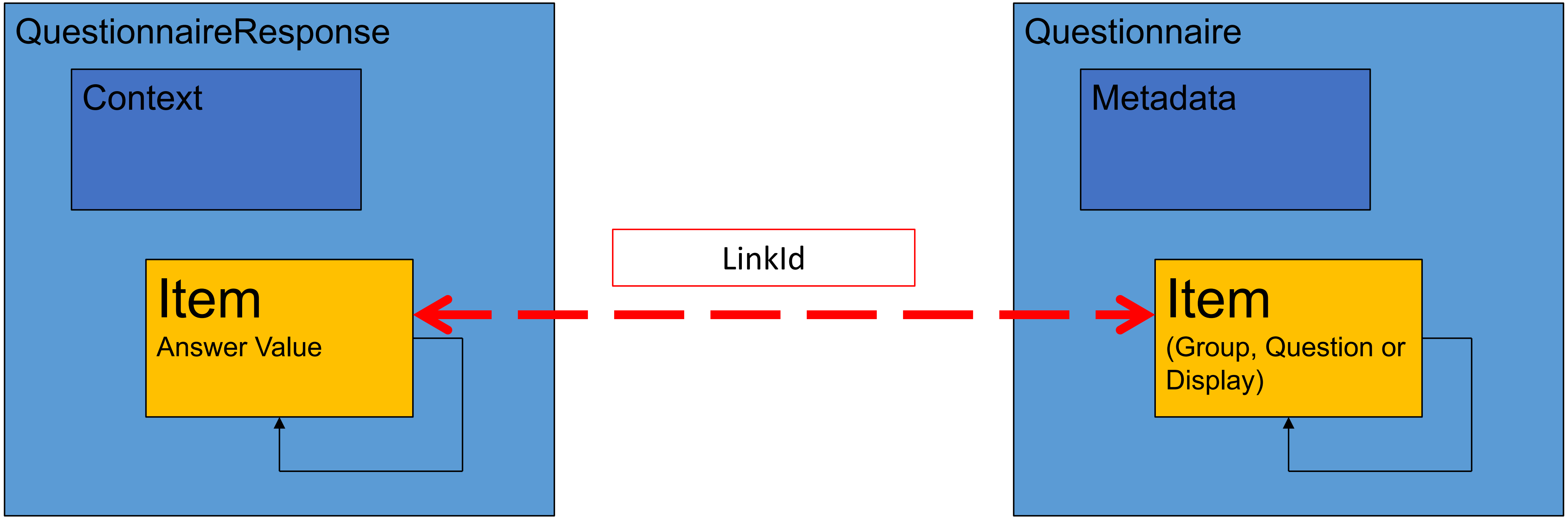
Special Resources



Even bind to terminologies



Special Resources



Special Resources

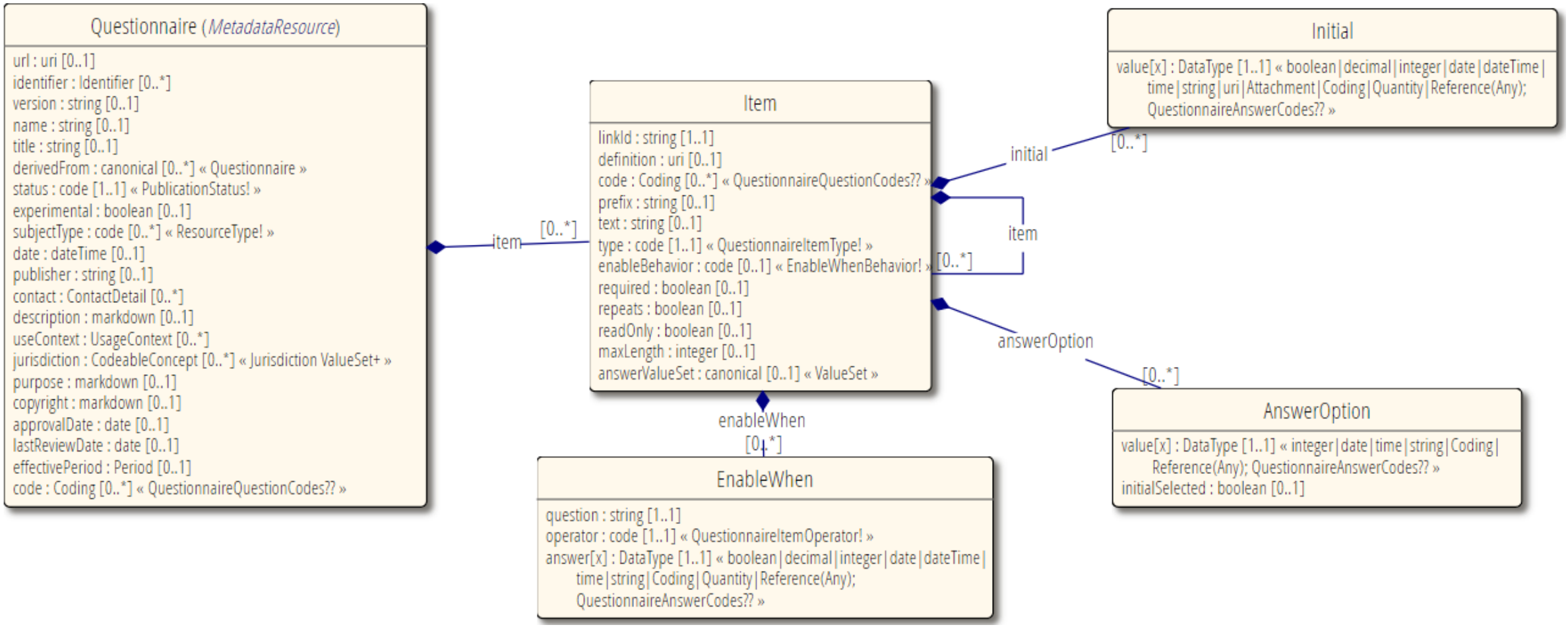
Questionnaire

```
<item>
  <linkId value="G1"/>
  <text value="Test questions"/>
  <type value="group"/>
  <repeats value="true"/>
  <item>
    <linkId value="Q1"/>
    <text value="What is your name?"/>
    <type value="string"/>
  </item>
  <item>
    <linkId value="Q2"/>
    <text value="What is your quest?"/>
    <type value="string"/>
  </item>
  <item>
    <linkId value="Q3"/>
    <text value="What is your favorite colour?"/>
    <type value="string"/>
  </item>
</item>
```

QuestionnaireResponse

```
<item>
  <linkId value="G1"/>
  <text value="Test questions"/>
  <item>
    <linkId value="Q1"/>
    <text value="What is your name?"/>
    <answer>
      <valueString value="Sir Lancelot of Camelot"/>
    </answer>
  </item>
  <!-- ... -->
</item>
<item>
  <linkId value="G1"/>
  <text value="Test questions"/>
  <item>
    <linkId value="Q1"/>
    <text value="What is your name?"/>
    <answer>
      <valueString value="Sir Robin of Camelot"/>
    </answer>
  </item>
  <!-- ... -->
</item>
```

Special Resources



Special Resources

TYPE

Groups

- Organize content of questionnaire
- Must have children
- Can't have answers

Questions

- Solicit information
- Must have answers (but can be optional)

Display

- Additional text, no children, no answers
- No subitems and no answer

2.1) What kind of Coffee would you like to have?

(pick 1)

- latte
- decaff
- Expresso
- mocha
- Other

Please state which one? _____

Special Resources

prefix | text

2.1) What kind of Coffee would you like to have?

(pick 1)

Subitem **display** type

- latte
- decaff
- Expresso
- mocha
- Other

Options (may be binded to valueSet)

Conditional Subitem that is a question for when answering other

Please state which one? _____

Resources – ”Special” cases

Extension

Enables flexibility

Modifier Extension

Modifier flexibility

Narrative

Supports human-readability

Versions

FHIR vs Resource vs Logical

Resources – Extensions

- Only include data elements in the artifacts if 80% of all implementers of that artifact will use the data element

Design for the 80%, not 100%

Allow easy extension for the remaining 20% of elements

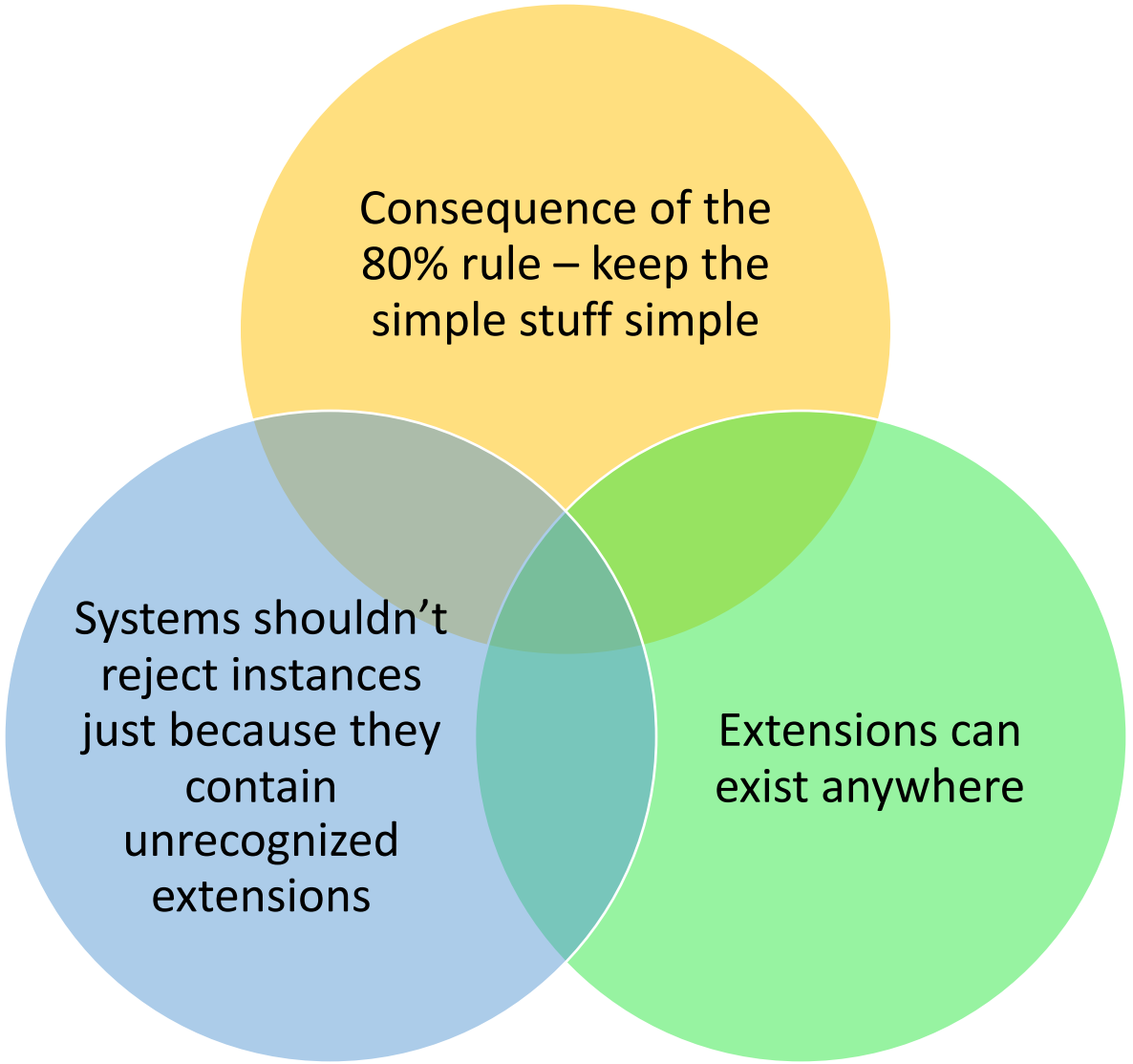
- Guidance, not constraining

- Not what the modelers thought, or designers need to remember

Focus publication on documenting what the implementer needs

https://github.com/HL7/documents/blob/master/presentations/Introduction%20to%20FHIR.pptx

Resources – Extensions



https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

Resources – Extensions

JSON Template

```
{
  "resourceType" : "Patient",
  // from Resource: id, meta, implicitRules, and language
  // from DomainResource: text, contained, extension, and modifierExtension
  "identifier" : [{ Identifier }], // An identifier for this patient
  "active" : <boolean>, // Whether this patient's record is in active use
  "name" : [{ HumanName }], // A name associated with the patient
  "telecom" : [{ ContactPoint }], // A contact detail for the individual
  "gender" : "<code>", // male | female | other | unknown
  "birthDate" : "<date>", // The date of birth for the individual
  // deceased[x]: Indicates if the individual is deceased or not. One of these 2:
  "deceasedBoolean" : <boolean>,
  "deceasedDateTime" : "<dateTime>",
  "address" : [{ Address }], // An address for the individual
  "maritalStatus" : { CodeableConcept }, // Marital (civil) status of a patient
  // multipleBirth[x]: Whether patient is part of a multiple birth. One of these 2:
  "multipleBirthBoolean" : <boolean>,
  "multipleBirthInteger" : <integer>,
  "photo" : [{ Attachment }], // Image of the patient
  "contact" : [{ // A contact party (e.g. guardian, partner, friend) for the patient
    "relationship" : [{ CodeableConcept }], // The kind of relationship
    "name" : { HumanName }, // A name associated with the contact person
    "telecom" : [{ ContactPoint }], // A contact detail for the person
    "address" : { Address }, // Address for the contact person
    "gender" : "<code>", // male | female | other | unknown
    "organization" : { Reference(Organization) }, // C? Organization that is associated with the
```

Structure | UML | XML | JSON | Turtle | R3 Diff | All

Structure

Name	Flags	Card.	Type	Description & Constraints
Extension	I N		Element	Optional Extensions Element *+ Rule: Must have either extensions or value[x], not both* Elements defined in Ancestors: id, extension
url		1..1	uri	identifies the meaning of the extension
value[x]		0..1	*	Value of extension

Documentation for this format

Nota: Value[x] can be all posible data types

https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

Resources – Extensions

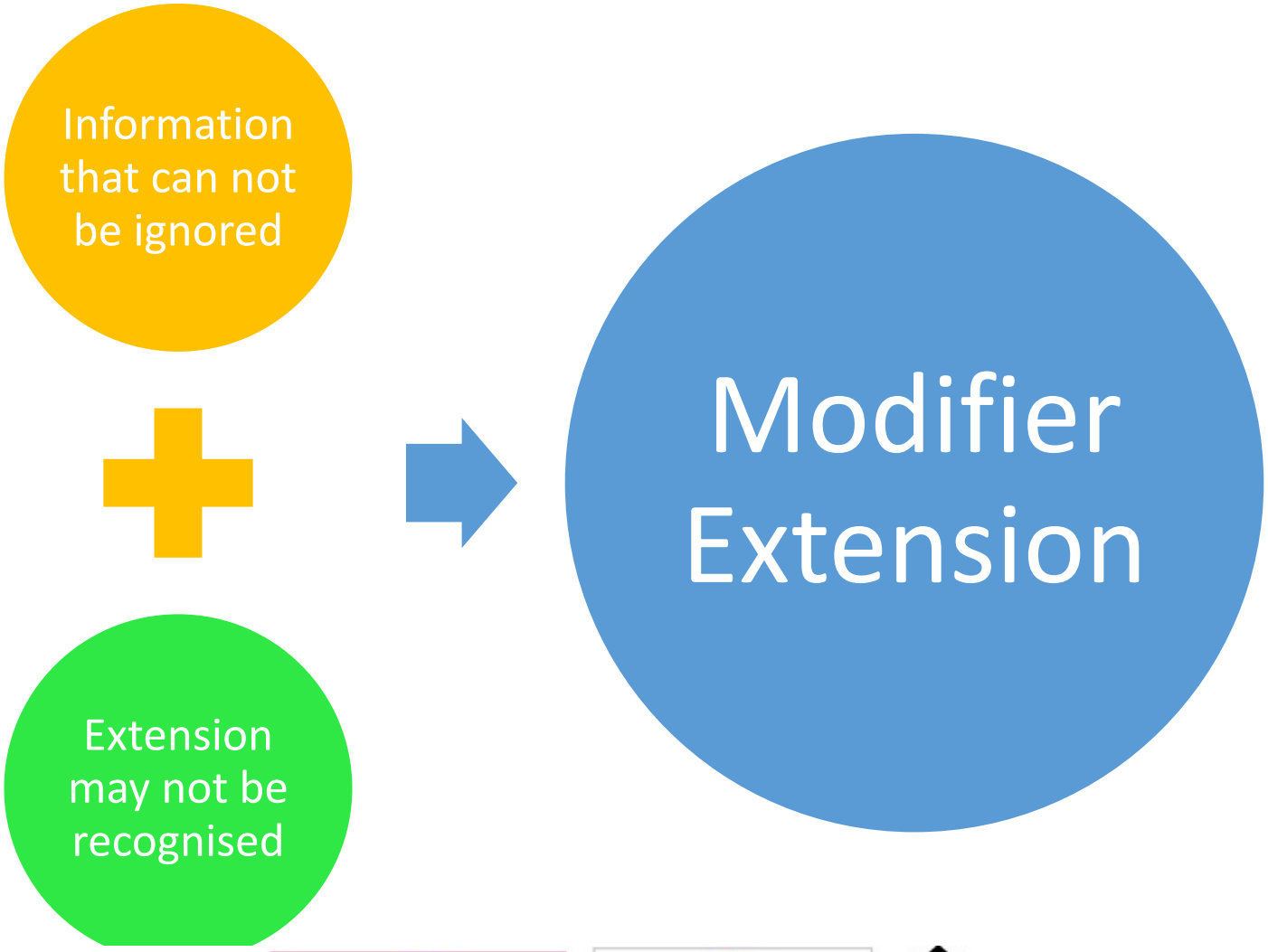
http://hl7.org/fhir/extension-iso21090-en-use.html

Name	Flags	Card.	Type	Description & Constraints
EN-use		0..1	code	URL = http://hl7.org/fhir/StructureDefinition/iso21090-EN-use EN-use: A set of codes advising a system or user which name in a set of names to select for a given purpose. **Binding:** EntityNameUseR2 (required) Use on Element ID HumanName

Documentation for this format

https://github.com/HL7/documents/blob/master/presentations/FHIR%20Overview.pptx

Resources – Modifier Extensions



Needed because some extensions can't be safely ignored

Resources – Modifier Extensions

There's no element on MedicationRequest to write an "anti-prescription" - an instruction not to take a medication for a particular period.

Classical clinical recording systems do not record this as a prescription - but one particular system does, and these "anti-prescription" records need to be shared within the institution where this happens as they are an important part of the workflow. Hence, applications are allowed to extend a resource with data like this:

Last resource

MedicationRequest

Att1
Att2
Att3
modifierExtension:
anti-prescription = True

Other HIS

Extensions are not default, may not be understood. **HOWEVER**, we do know modifier extensions can not be ignored – **Crisis avoided**

Resources – Narrative

2.27.2 Boundaries and Relationships

This resource extends the base Resource. All of the listed Resources except Bundle, Parameters and Binary extend this resource.

2.27.3 Resource Content

Structure | UML | XML | JSON | Turtle | All

Structure

Name	Flags	Card.	Type	Description & Constraints
DomainResource	«A» N		Resource	A resource with narrative, extensions, and contained resources *+ Rule: If the resource is contained in another resource, it SHALL NOT contain nested Resources* *+ Rule: If the resource is contained in another resource, it SHALL be referred to from elsewhere in the resource or SHALL refer to the containing resource* *+ Rule: If a resource is contained in another resource, it SHALL NOT have a meta.versionId or a meta.lastUpdated* *+ Rule: If a resource is contained in another resource, it SHALL NOT have a security label* *+ Guideline: A resource should have narrative for robust management* Elements defined in Ancestors: id, meta, implicitRules, language
text		0..1	Narrative	Text summary of the resource, for human interpretation
contained	I	0..*	Resource	Contained, inline Resources *+ Warning: Containing new R4B resources within R4 resources may cause interoperability issues if instances are shared with R4 systems*
extension		0..*	Extension	Additional content defined by implementations
modifierExtension	?!	0..*	Extension	Extensions that cannot be ignored

Documentation for this format

Any resource that is a DomainResource (all resources except Bundle, Parameters and Binary) may include a human-readable narrative that contains a summary of the resource and may be used to represent the content of the resource to a human.

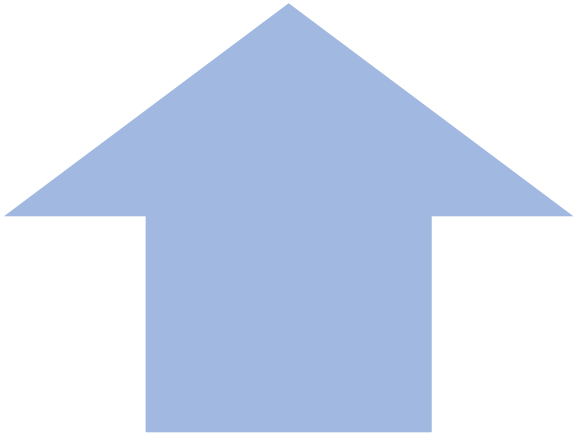
Resources – Narrative

Automatically generated

Generated simplifies processing for receivers

Context that may be edited on added by human.

Manually edited



https://github.com/rhiky/documents/blob/master/presentations/rhik%20Overview.pptx

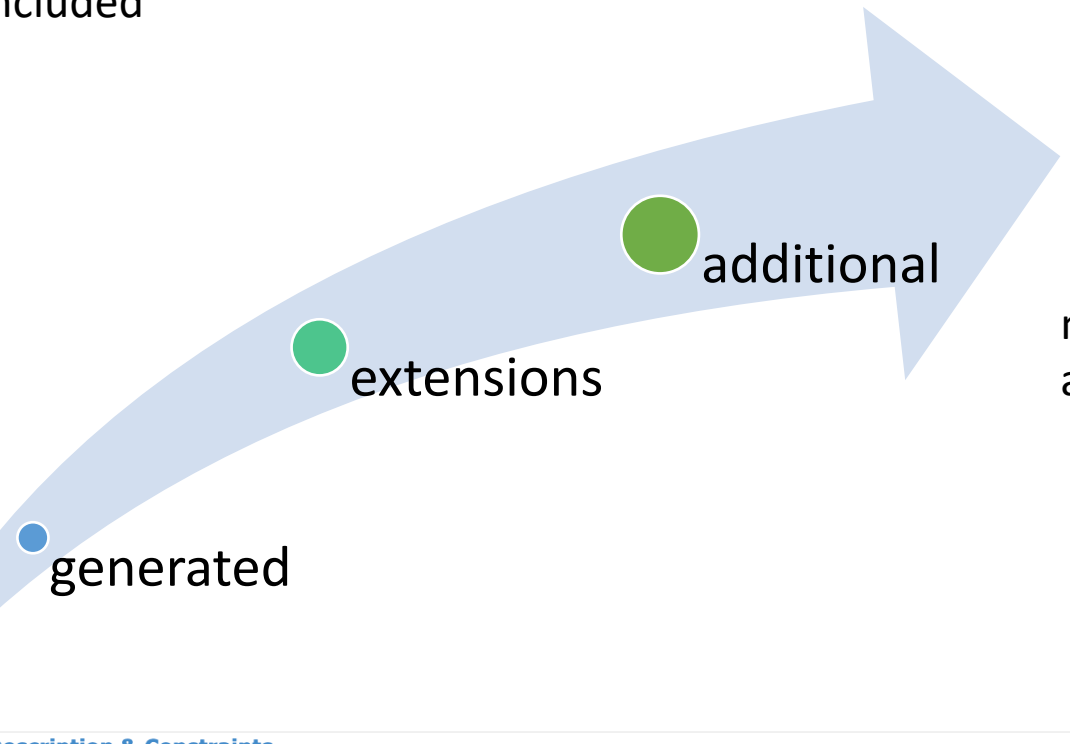
If generated, which elements should be included?

All content needed for a human to understand the essential clinical and business information otherwise encoded within the resource

https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

Resources – Narrative

If extensions are included



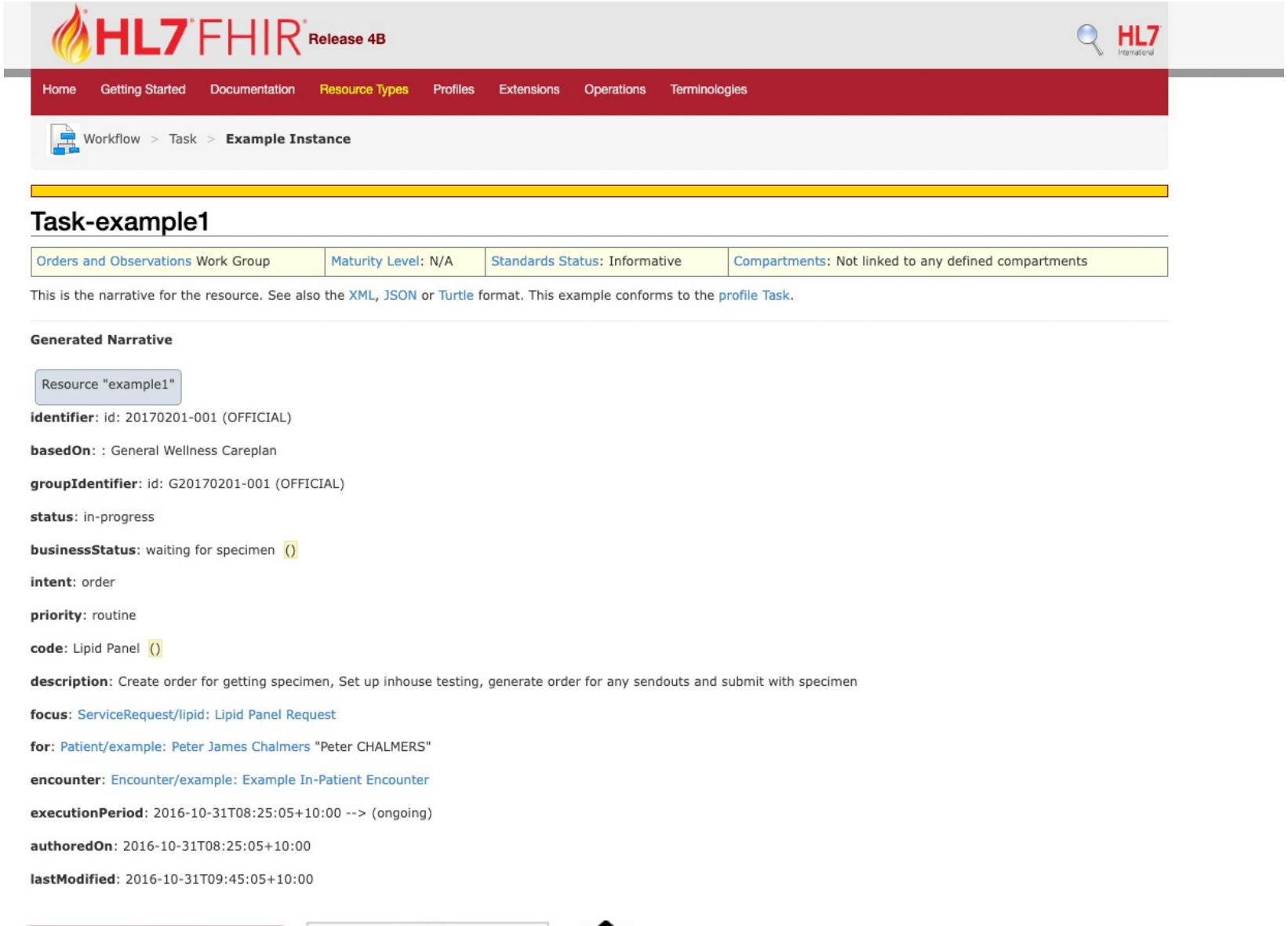
must always make narrative available to view

If automatically generated

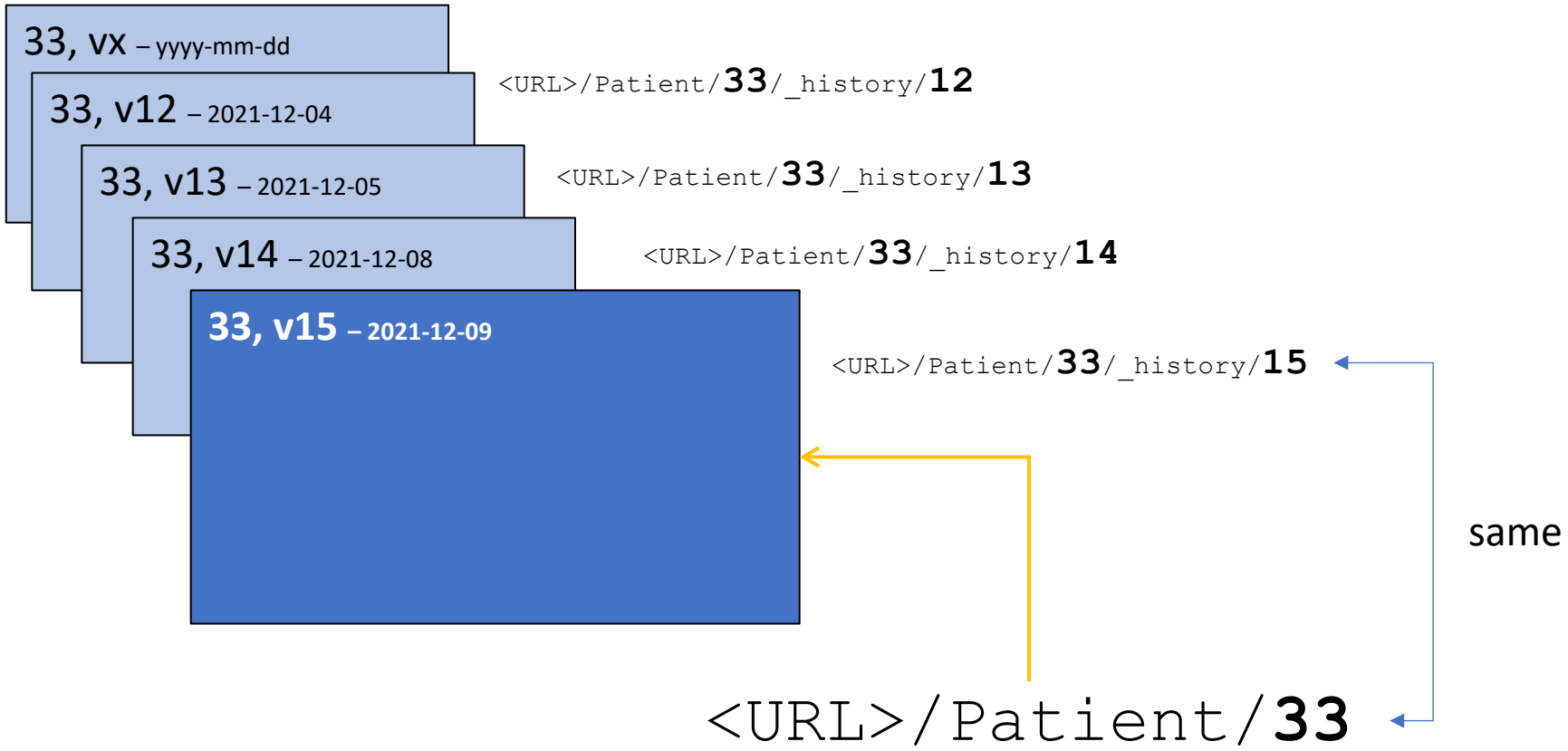
Name	Flags	Card.	Type	Description & Constraints
Narrative	N		Element	Human-readable summary of the resource (essential clinical and business information) Elements defined in Ancestors: id, extension
status		1..1	code	generated | extensions | additional | empty NarrativeStatus (Required)
div	I	1..1	xhtml	Limited xhtml content *+ Rule: The narrative SHALL contain only the basic html formatting elements and attributes described in chapters 7-11 (except section 4 of chapter 9) and 15 of the HTML 4.0 standard, <a> elements (either name or href), images and internally contained style attributes* *+ Rule: The narrative SHALL have some non-whitespace content*

https://github.com/HL7/documents/blob/master/presentations/FHIR%20Overview.pptx

Resources – Narrative



Resources – Versions



Resources – Versions

Different versions

- Resource versions
- FHIR version
- ”Business” version - > valueSet versions

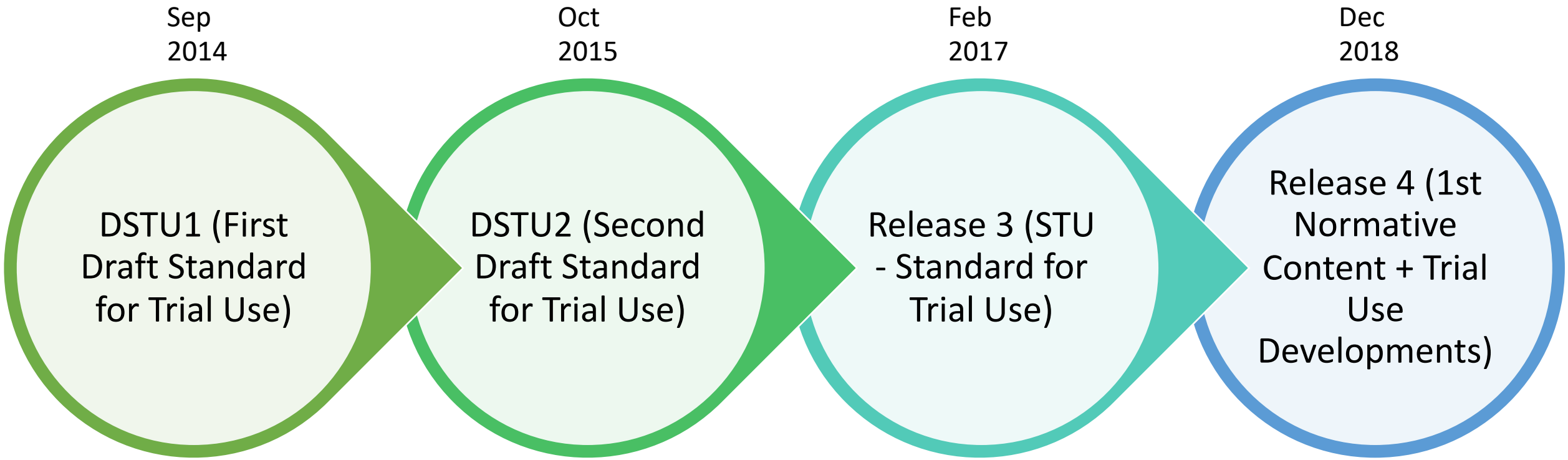
```
<ValueSet>
  <meta>
    <versionId value="v2"/>
  </meta>
</ValueSet>
```

```
{
  "resourceType" : "Patient",
  "meta" : {
    "profile" : ["http://hl7.org/fhir/3.0/StructureDefinition/Patient"]
  }
}
```

```
<ValueSet>
  <url value="http://acme.com/fhir/ValueSet/example"/>
  <version value="2.0"/>
</ValueSet>
```


https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

FHIR versions



+ R5 as dev atm

FHIR Maturity Model

FMM0

Published Draft

FMM1

No Warning

WG Approval

FMM2

Tested by 3 independent systems for 80%+ scope

FMM3

Meet the quality guidelines

Formal ballot

Comments

FMM4

1 Formal publication cycle

Multiple implementations

Backward changes require consulting implementers

FMM5

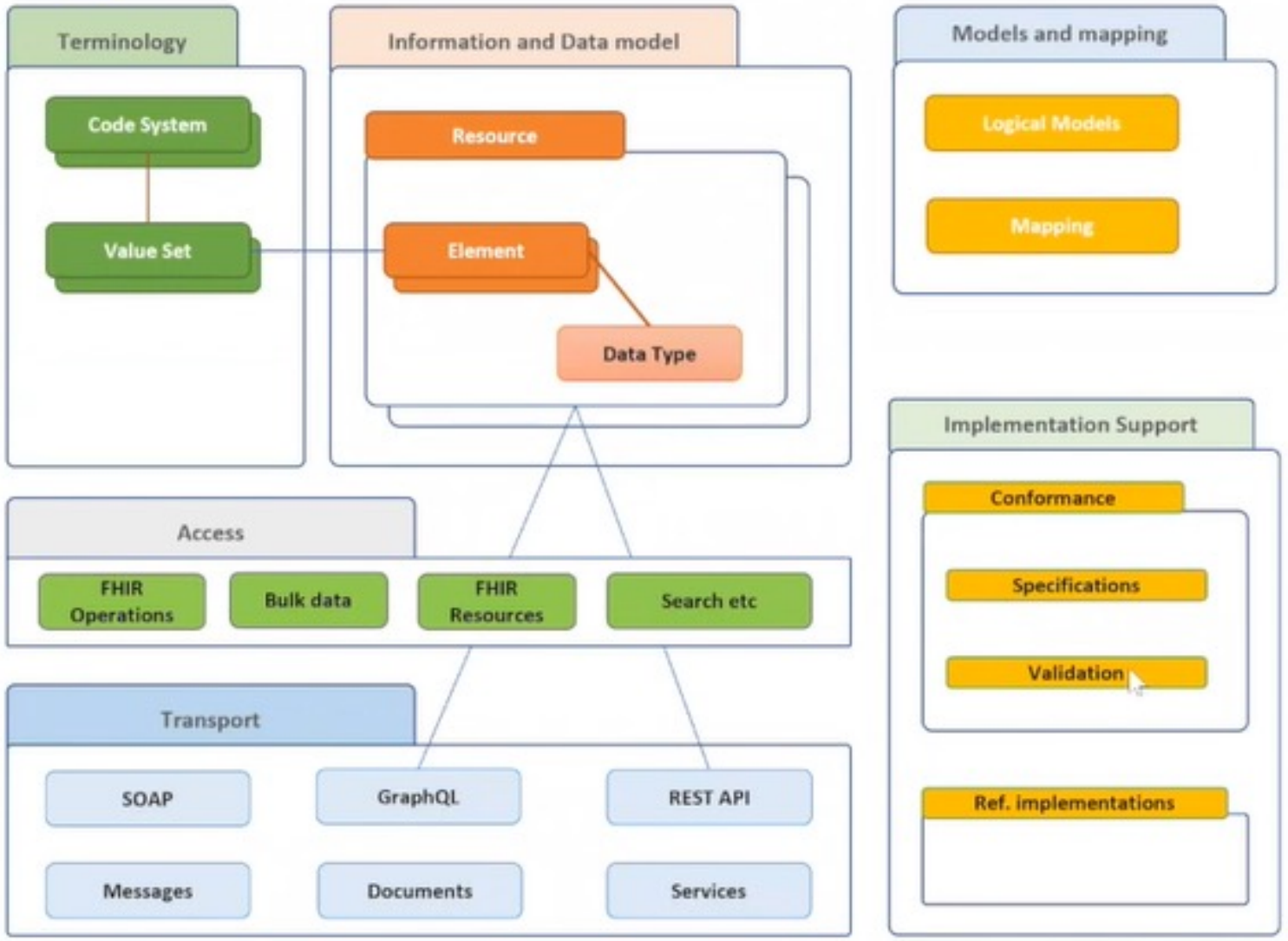
2 Formal Publication cycles

5 independent publications in more than one country

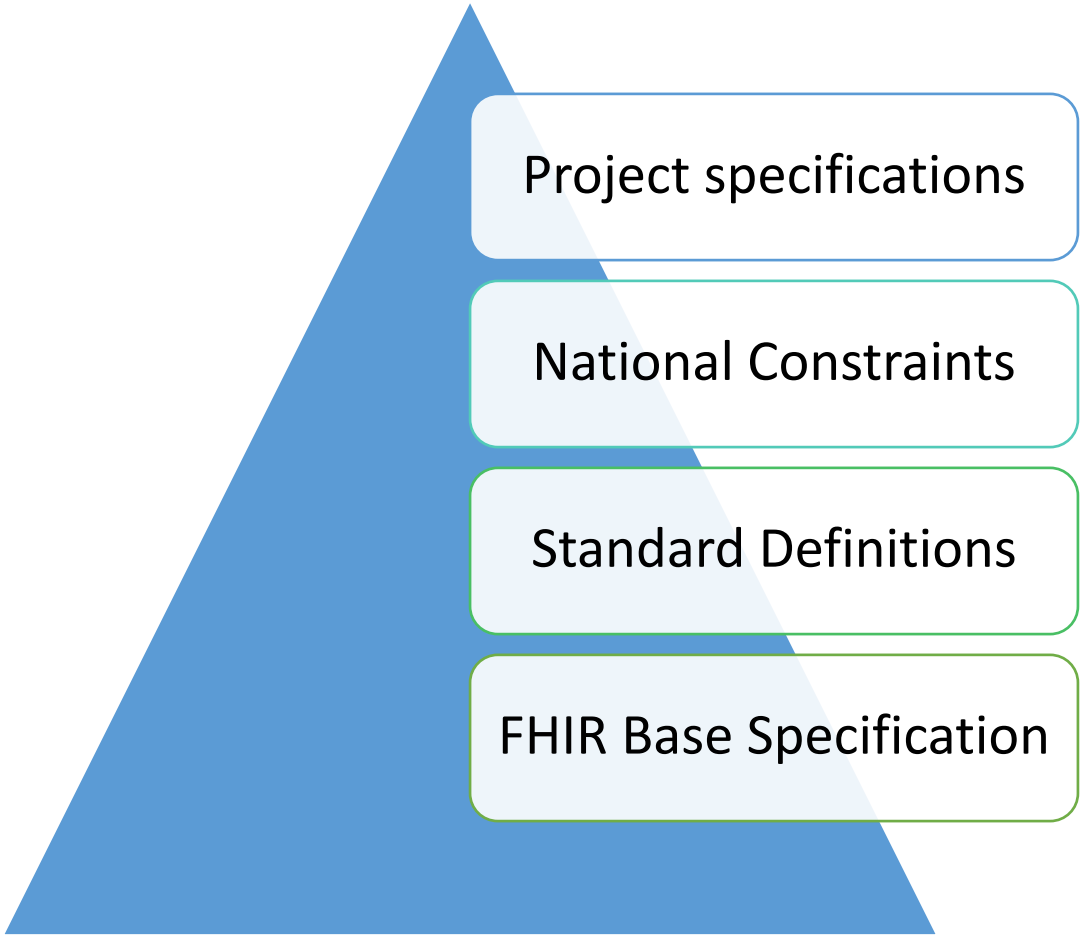
FHIR Profiling

FHIR Resources and profiles

- Resources are nothing more than agreed upon data structures
- Can be extended or restrained (profiling)



FHIR Profiling



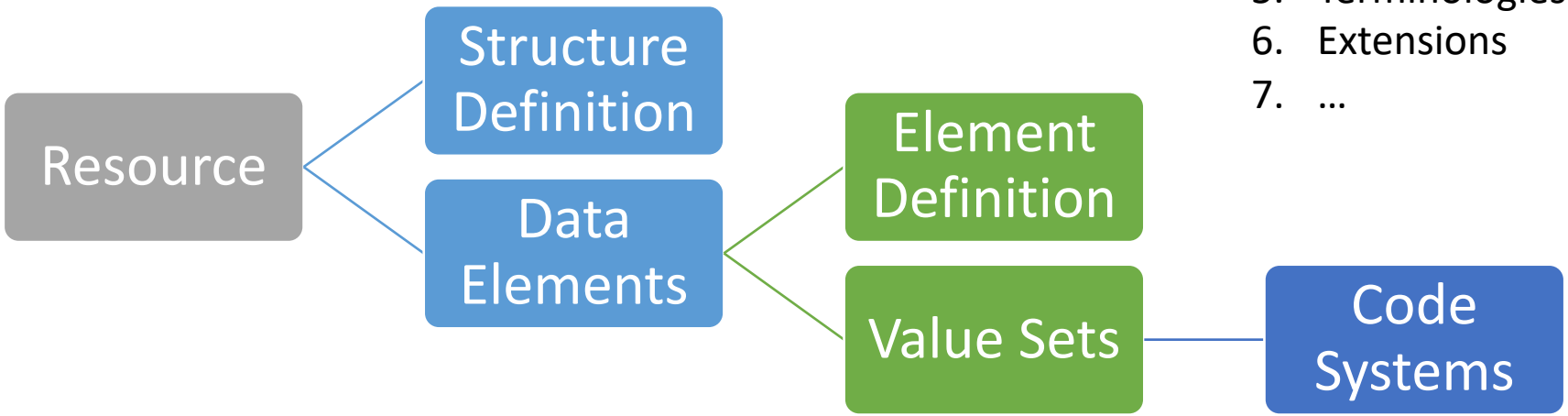
Greater restrictions, not less

FHIR Profiling

A FHIR profile is a restrained or extended FHIR Resource

- A FHIR profile derives from base resource or even another profile.
- Examples:
  - ptMedication stems from Medication Knowledge
  - ptPatient stems from Patient
  - myUSPatient stems from USCore Patient profile
  - …

1. Change names
2. constrain cardinalities
3. Restrict codes
4. What should be supported
5. Terminologies
6. Extensions
7. …

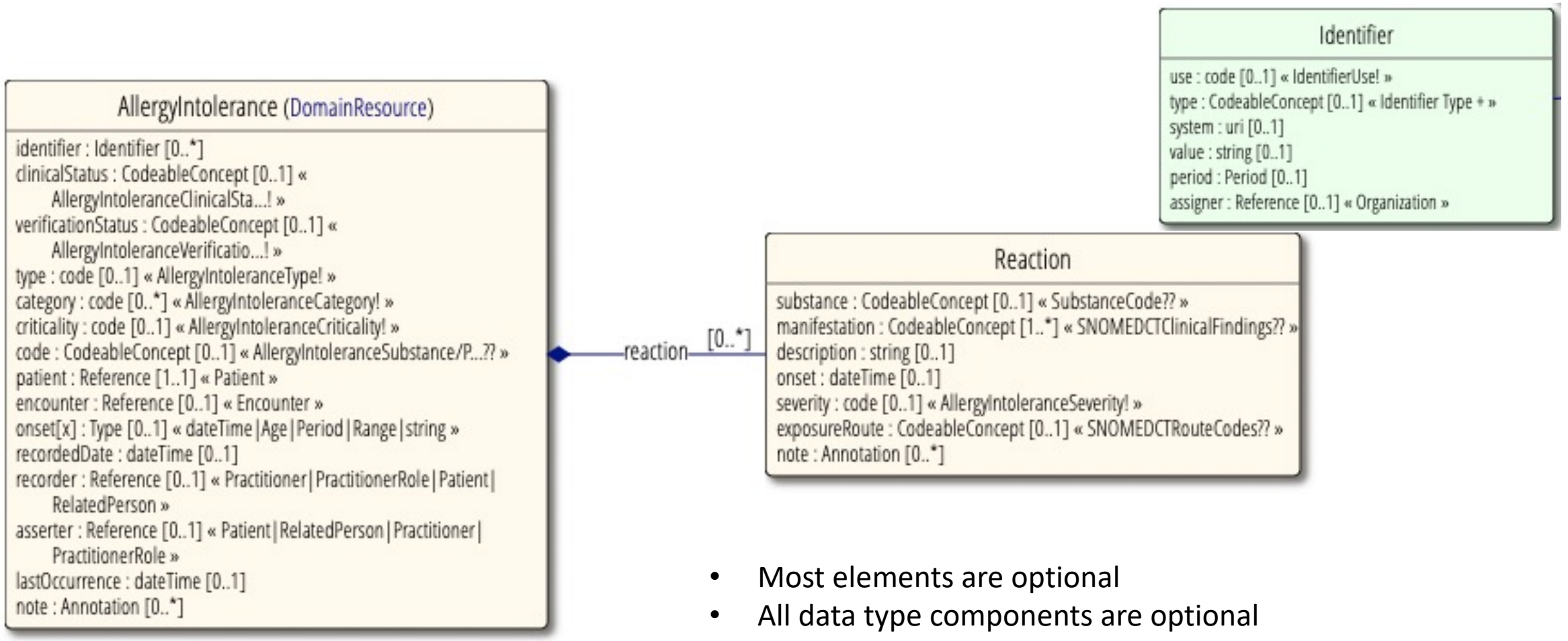


StructureDefinition – metadata and element

Profiles are technical tools. However they can only work out as intended with tight collaboration between clinical and tech staff.

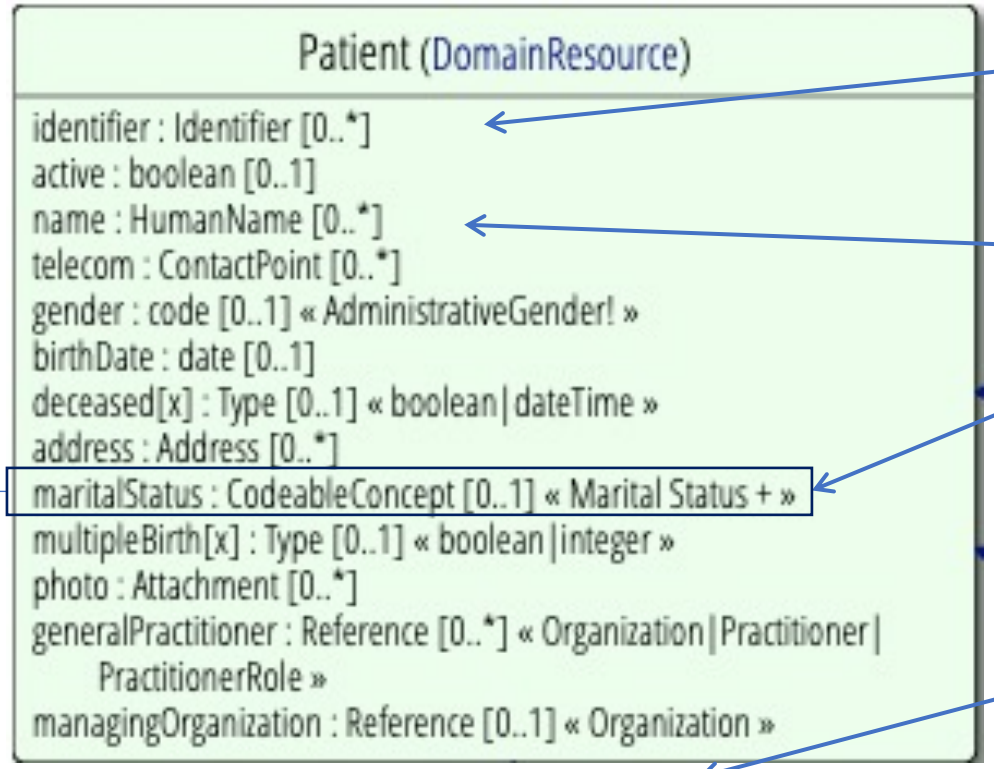
https://digitalsq

FHIR Profiling



- Most elements are optional
- All data type components are optional
- Most terminologies unconstrained

FHIR Profiling



Demanding the usage of national identifier of patient

Limit name to only 1 (instead of multiple)

Limit maritalStatus to another value set

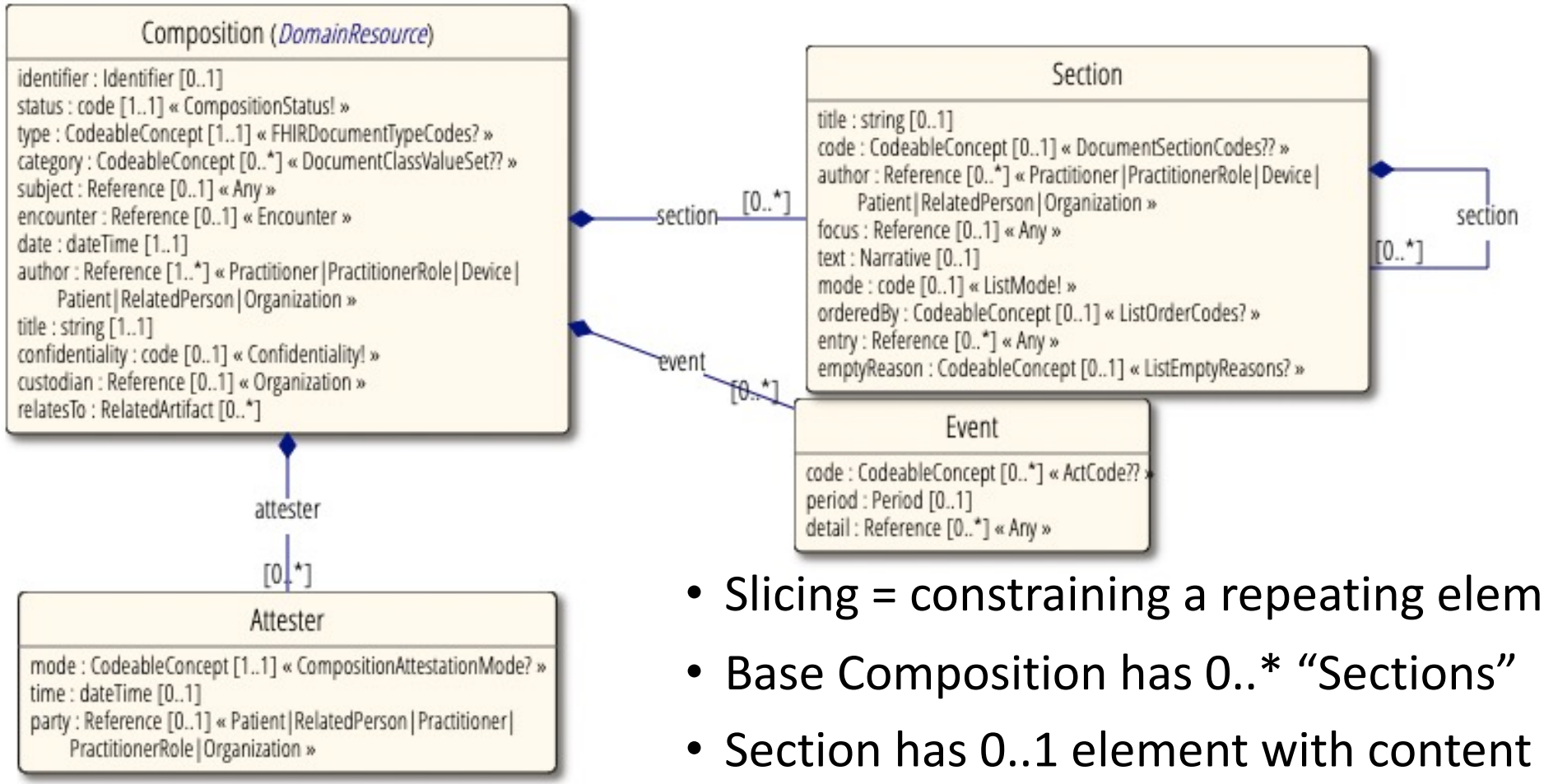
Add an extension for “profession”

Bindings: **Required** vs **Extensible**

https://github.com/FHIR/documents/blob/master/presentations/IG%20for%20DaVinci.pptx

FHIR Profiling

Example Composition (aka Document header)



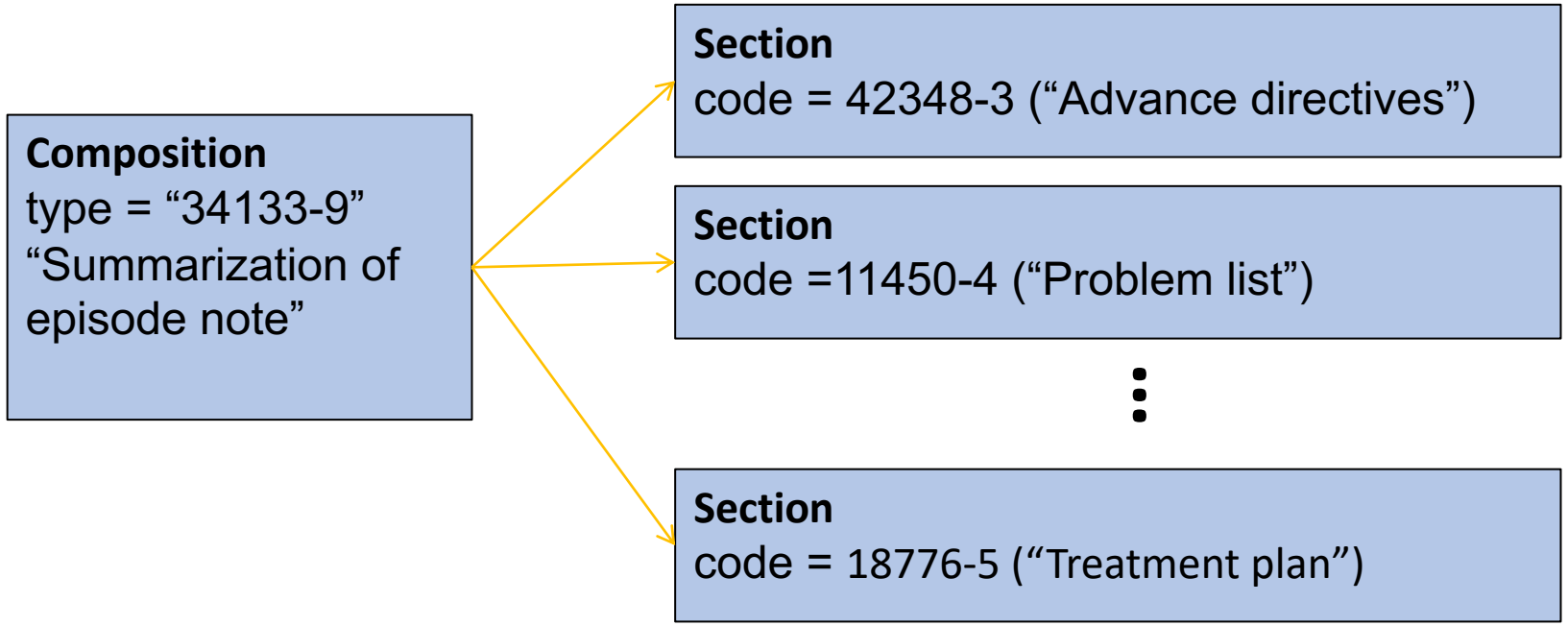
- Slicing = constraining a repeating element
- Base Composition has 0..* “Sections”
- Section has 0..1 element with content

https://github.com/FHIR/documents/blob/master/presentations/IG%20101%20Davinci.pptx

FHIR Profiling

So…

Códigos LOINC



"Slice" the repeating sections into a fixed set of profiled sections.

https://github.com/FHIR/documents/blob/master/presentations/IG%20101%20Davinci.pptx

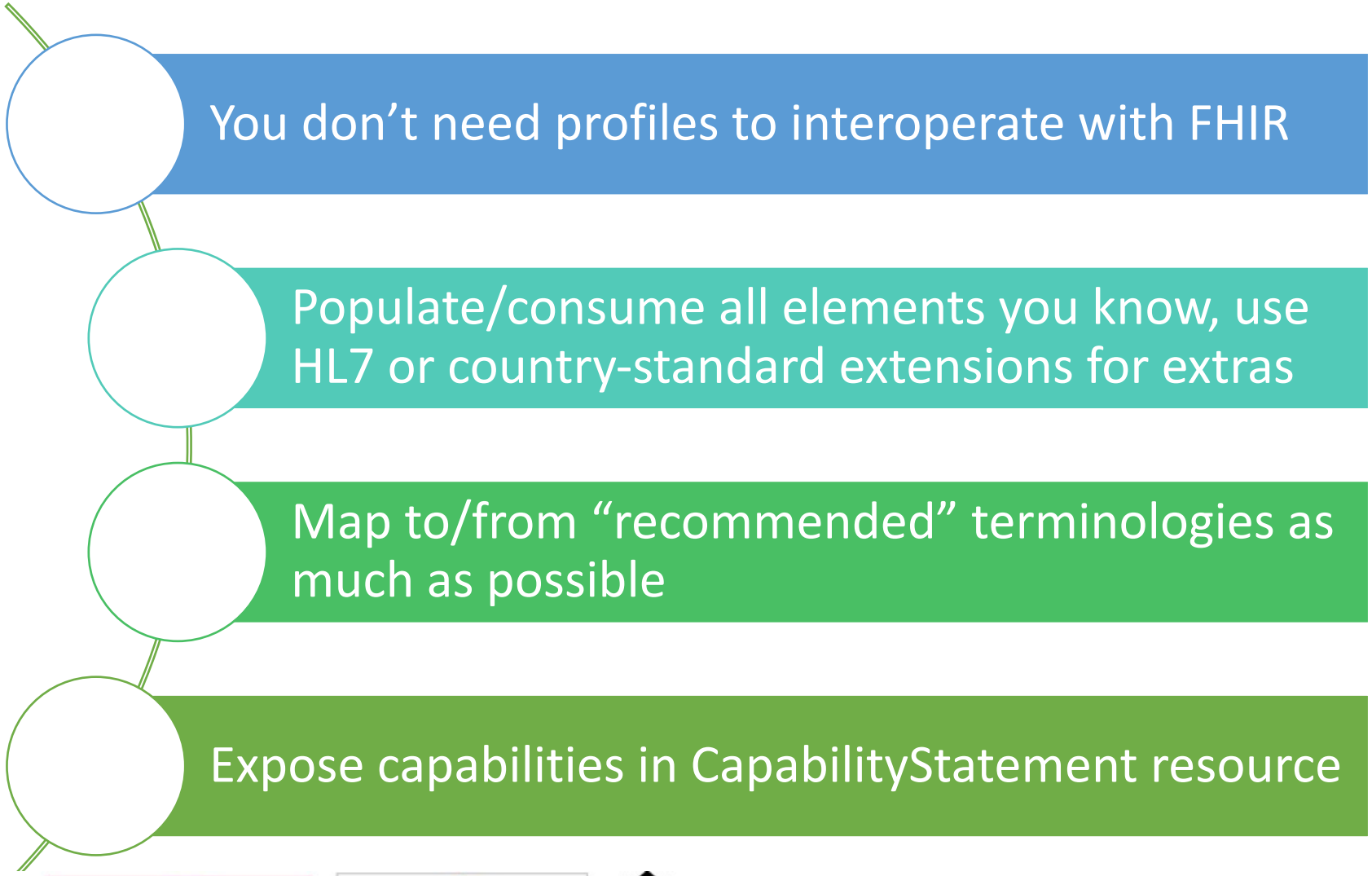
FHIR Profiling

Profiled Observation (Blood Pressure)

Name	Flags	Card.	Type	Description & Constraints
Observation		0..*		FHIR Blood Pressure Profile
code		1..1	CodeableConcept	Blood Pressure
coding			*(Slice Definition)*	***Slice:*** *Unordered, Open by value:code, value:system*
coding:BPCode		1..1	Coding	
system		1..1	uri	**Fixed Value:** http://loinc.org
code		1..1	code	**Fixed Value:** 85354-9
~~valueQuantity~~		~~0..0~~		
component			*(Slice Definition)*	***Slice:*** *Unordered, Open by value:code.coding.code, value:code.coding.system*
component:SystolicBP		1..1	BackboneElement	
code		1..1	CodeableConcept	
coding			*(Slice Definition)*	*Systolic Blood Pressure* ***Slice:*** *Unordered, Open by value:code, value:system*
coding:SBPCode		1..1	Coding	Systolic Blood Pressure
system		1..1	uri	**Fixed Value:** http://loinc.org
code		1..1	code	**Fixed Value:** 8480-6
valueQuantity		0..1	Quantity	
value	S	1..1	decimal	
unit	S	1..1	string	
system	S	1..1	uri	**Fixed Value:** http://unitsofmeasure.org
code	S	1..1	code	Coded responses from the common UCUM units for vital signs value set. **Fixed Value:** mm[Hg]

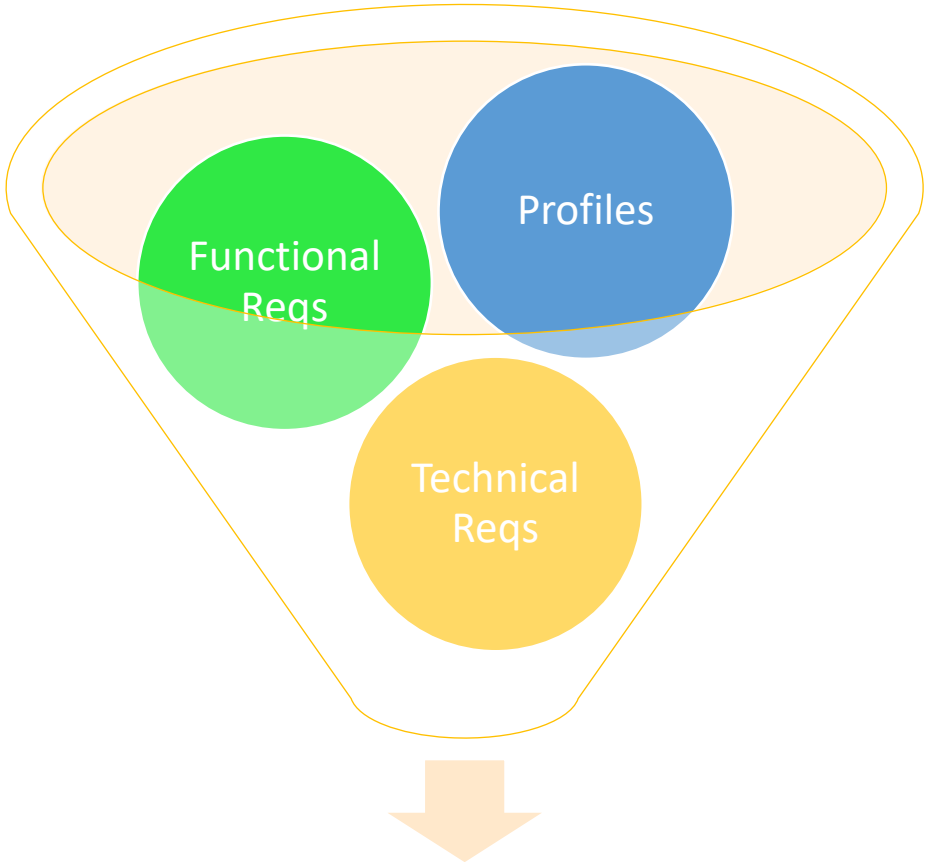
FHIR Profiling

Profile-less FHIR



https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

FHIR Implementation Guides



Narrative
Examples
Specs
Testing
an Atual implementation guide
…

IG

Cross-sectional collaboration -> Web publication for meeting implementers needs

FHIR Implementation Guides

Are packages of FHIR conformance resources relevant to solving a particular interoperability need

Also include additional human-readable documentation to guide implementation

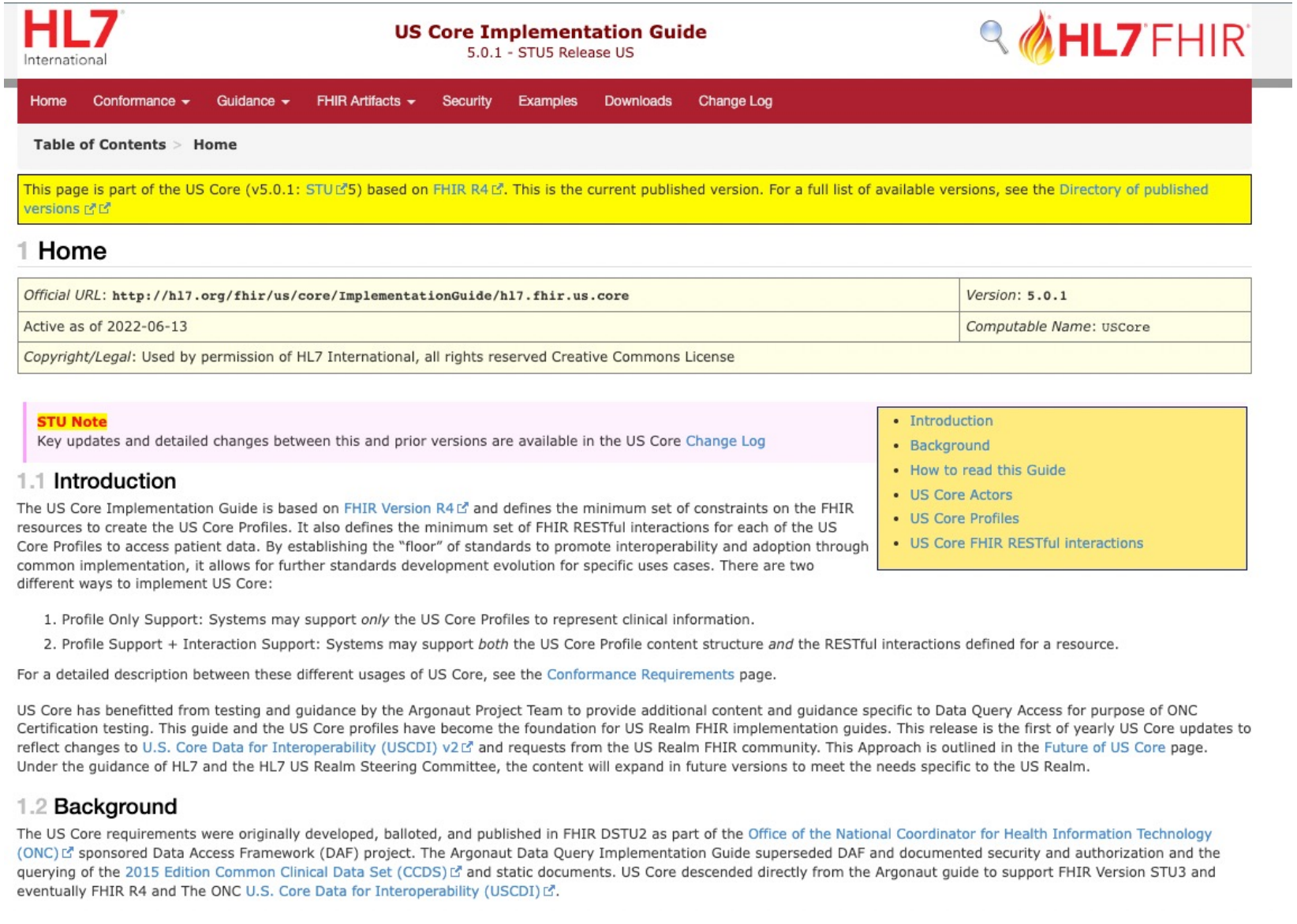
Provide support for validation of solutions that claim conformance with the IG

Can build on other implementation guides

Are defined by a FHIR ImplementationGuide resource

https://github.com/FHIR/documents/blob/master/presentations/IG%20101%20Davinci.pptx

https://www.hl7.org/fhir/us/core/



HL7 International

US Core Implementation Guide
5.0.1 - STU5 Release US

HL7 FHIR

Home | Conformance | Guidance | FHIR Artifacts | Security | Examples | Downloads | Change Log

Table of Contents > Home

This page is part of the US Core (v5.0.1: STU5) based on FHIR R4. This is the current published version. For a full list of available versions, see the Directory of published versions

1 Home

Official URL: `http://hl7.org/fhir/us/core/ImplementationGuide/hl7.fhir.us.core`	*Version*: `5.0.1`
Active as of 2022-06-13	*Computable Name*: `USCore`
Copyright/Legal: Used by permission of HL7 International, all rights reserved Creative Commons License	

STU Note
Key updates and detailed changes between this and prior versions are available in the US Core Change Log

- Introduction
- Background
- How to read this Guide
- US Core Actors
- US Core Profiles
- US Core FHIR RESTful interactions

1.1 Introduction

The US Core Implementation Guide is based on FHIR Version R4 and defines the minimum set of constraints on the FHIR resources to create the US Core Profiles. It also defines the minimum set of FHIR RESTful interactions for each of the US Core Profiles to access patient data. By establishing the "floor" of standards to promote interoperability and adoption through common implementation, it allows for further standards development evolution for specific uses cases. There are two different ways to implement US Core:

1. Profile Only Support: Systems may support *only* the US Core Profiles to represent clinical information.
2. Profile Support + Interaction Support: Systems may support *both* the US Core Profile content structure *and* the RESTful interactions defined for a resource.

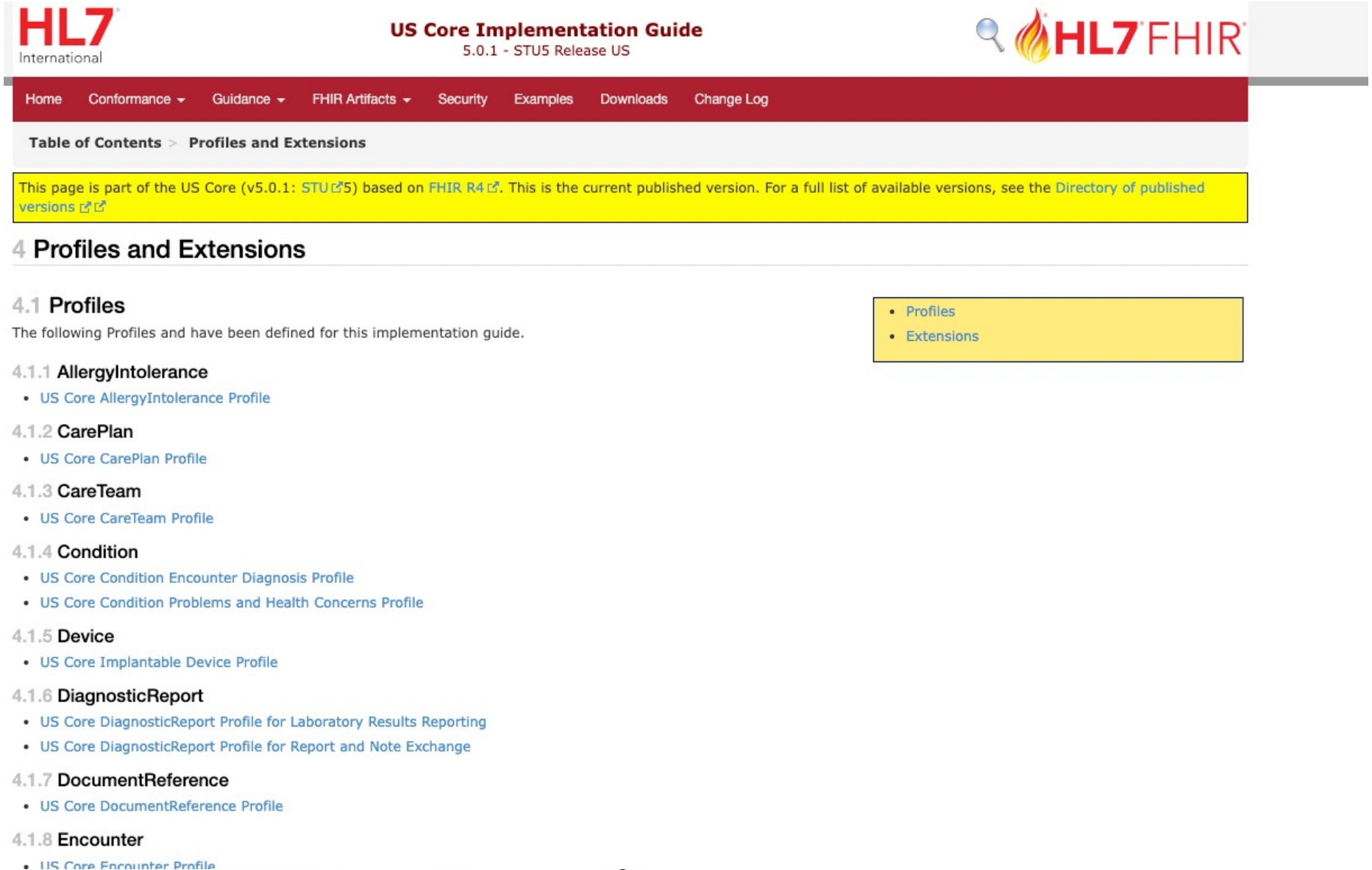
For a detailed description between these different usages of US Core, see the Conformance Requirements page.

US Core has benefitted from testing and guidance by the Argonaut Project Team to provide additional content and guidance specific to Data Query Access for purpose of ONC Certification testing. This guide and the US Core profiles have become the foundation for US Realm FHIR implementation guides. This release is the first of yearly US Core updates to reflect changes to U.S. Core Data for Interoperability (USCDI) v2 and requests from the US Realm FHIR community. This Approach is outlined in the Future of US Core page. Under the guidance of HL7 and the HL7 US Realm Steering Committee, the content will expand in future versions to meet the needs specific to the US Realm.

1.2 Background

The US Core requirements were originally developed, balloted, and published in FHIR DSTU2 as part of the Office of the National Coordinator for Health Information Technology (ONC) sponsored Data Access Framework (DAF) project. The Argonaut Data Query Implementation Guide superseded DAF and documented security and authorization and the querying of the 2015 Edition Common Clinical Data Set (CCDS) and static documents. US Core descended directly from the Argonaut guide to support FHIR Version STU3 and eventually FHIR R4 and The ONC U.S. Core Data for Interoperability (USCDI).

https://www.hl7.org/fhir/us/core/



HL7 International

US Core Implementation Guide
5.0.1 - STU5 Release US

HL7 FHIR

Home | Conformance | Guidance | FHIR Artifacts | Security | Examples | Downloads | Change Log

Table of Contents > Profiles and Extensions

This page is part of the US Core (v5.0.1: STU5) based on FHIR R4. This is the current published version. For a full list of available versions, see the Directory of published versions

4 Profiles and Extensions

4.1 Profiles

The following Profiles and have been defined for this implementation guide.

- Profiles
- Extensions

4.1.1 AllergyIntolerance

- US Core AllergyIntolerance Profile

4.1.2 CarePlan

- US Core CarePlan Profile

4.1.3 CareTeam

- US Core CareTeam Profile

4.1.4 Condition

- US Core Condition Encounter Diagnosis Profile
- US Core Condition Problems and Health Concerns Profile

4.1.5 Device

- US Core Implantable Device Profile

4.1.6 DiagnosticReport

- US Core DiagnosticReport Profile for Laboratory Results Reporting
- US Core DiagnosticReport Profile for Report and Note Exchange

4.1.7 DocumentReference

- US Core DocumentReference Profile

4.1.8 Encounter

- US Core Encounter Profile

SMART ON FHIR

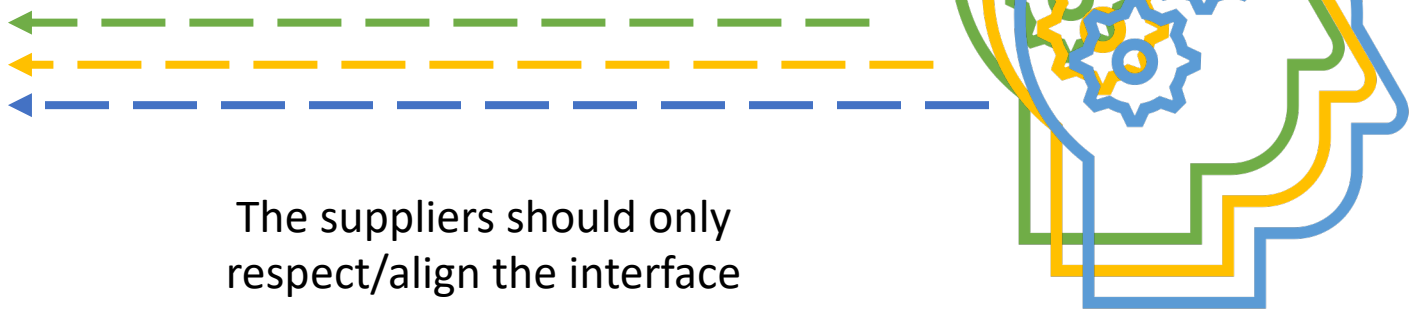
So how can we enhance the data processing abilities of a certain HIS in a systematic way?

SMART ON FHIR

How to interact with third parties to create an additional support/ advanced processing of data

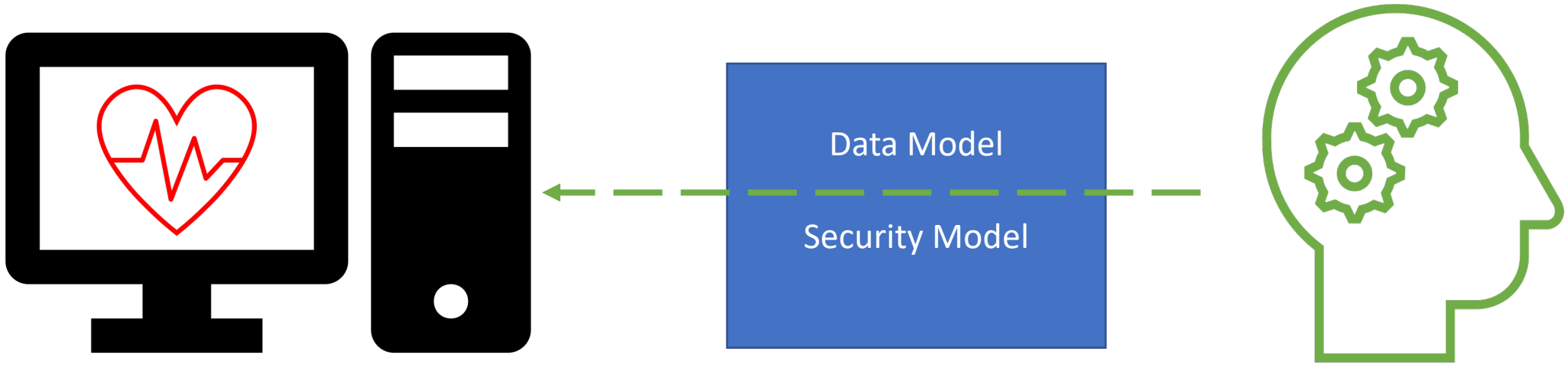
SMART ON FHIR

Create an interface for data exchange

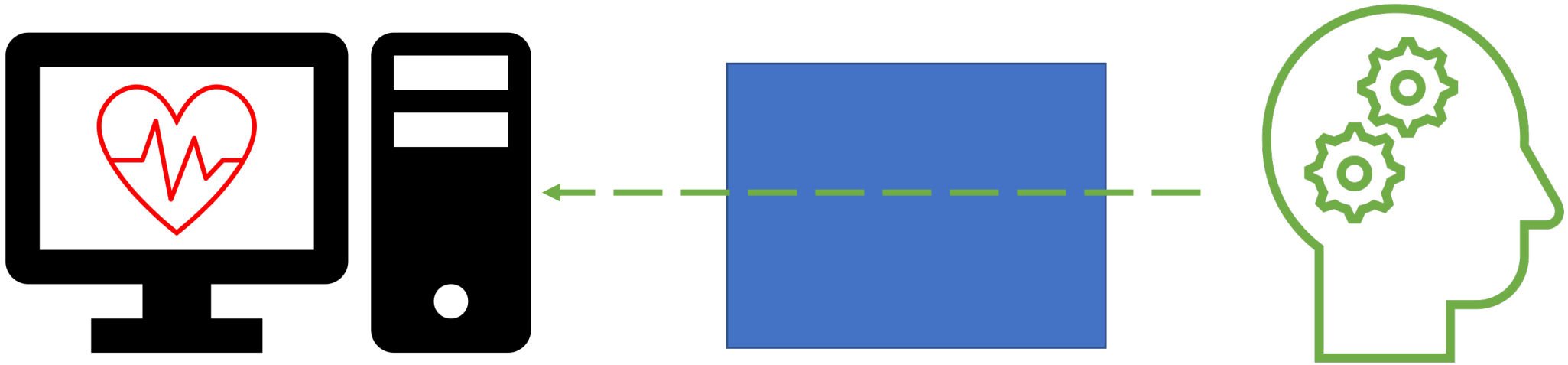


The suppliers should only respect/align the interface format

SMART ON FHIR

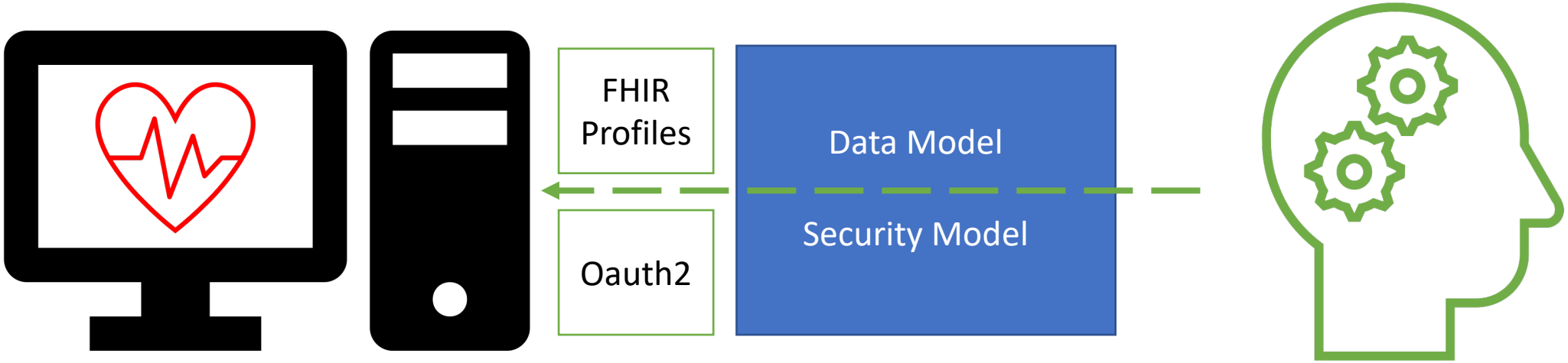


SMART ON FHIR



Substitutable Medical Applications & Reusable Technologies

SMART ON FHIR

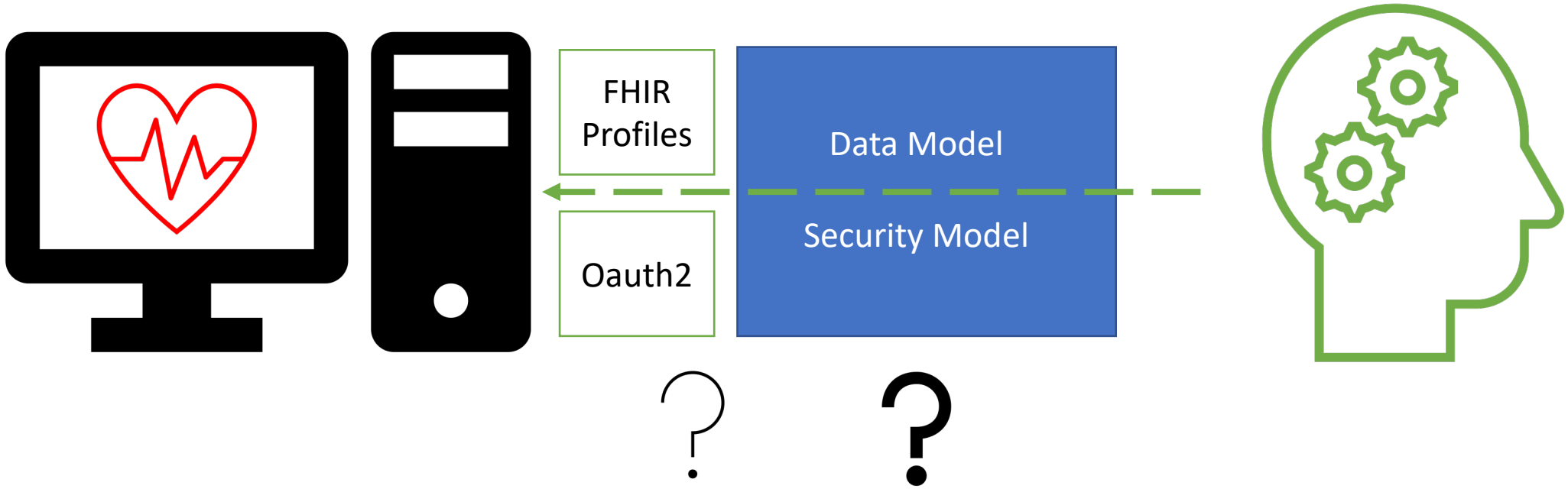


Smart on FHIR is a set of open specifications to integrate apps with healthcare data provider systems. It builds on top of the FHIR interface to add:

- A set of scopes and permissions **agreed between client and server** that are specific to the app context.
- A simple reliable and secure login process using OAuth2 and OpenID Connect.
- Consistent UI integration between client and server.
- Interactive decision support between user, server, and decision support systems.

SMART ON FHIR

HOWEVER…



The user needs to know the app is available
The user needs to know the app is relevant
The user has to find the app and launch it

CDS HOOKS

A vendor agnostic remote decision support specification

Triggered by HIS → Evaluates with its own logic using FHIR → Returns a decision support

CDS HOOKS

[Metoprolol]

Order by HIS

Rx Lopresor 50 mg / dia

1

Client triggers a CDS HOOK and invokes a remote service

CDS

2

CDS Service executes its own rules, leveraging FHIR data as needed

FHIR Server

3

Returns **CDS cards** (rendered by HIS/client)

information card

Total price (Patient price)

suggestion card

Try changing to Carvedilol

Switch to Carvedilol

smart app link card

Managing hypertension?

Launch JNC 8 Rx Pro

https://cds-hoc

CDS HOOKS

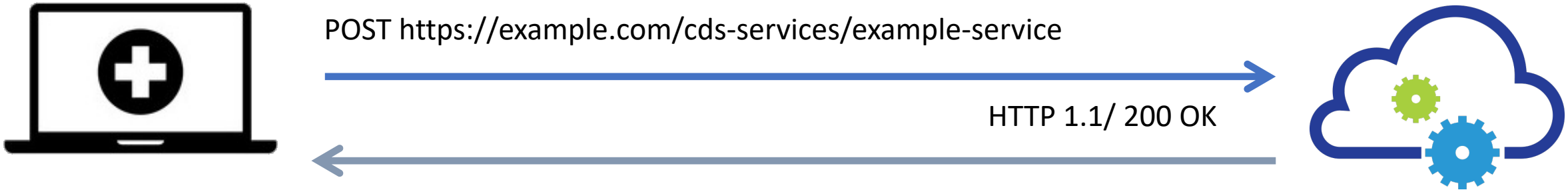
POST https://example.com/cds-services/example-service

```
{
  "hook": "patient-view”,
  "fhirServer": "https://fhir.example.com",
  "context": {
    "user": "Practitioner/789"
    "patientId": "123",
    "encounterId": "456",
  },
  ...
}
```

CDS HOOKS

POST https://example.com/cds-services/example-service

CDS HOOKS




```
{
  "cards": [
    {
      "summary": "Example card",
      "indicator": "info",
      "source": {
        "name": "Demo CDS Service”
}}]}
```

Cards

A service may return any number of cards

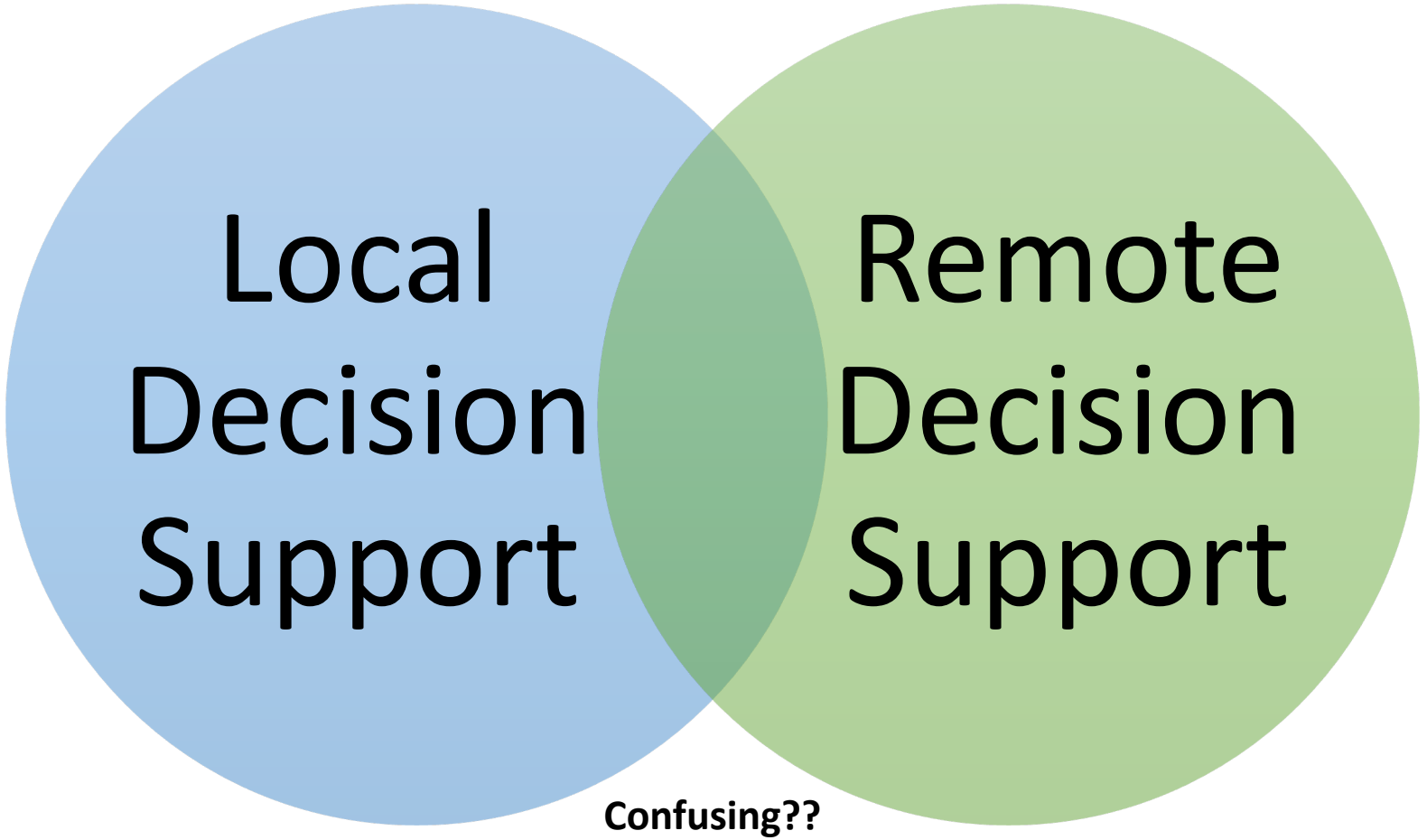
HIS render and show the information they need

Every card must have:

- Summary
- Importance level
- Information regarding the data that supported the decision

Clinical Reasoning

CDS HOOKS



Confusing??

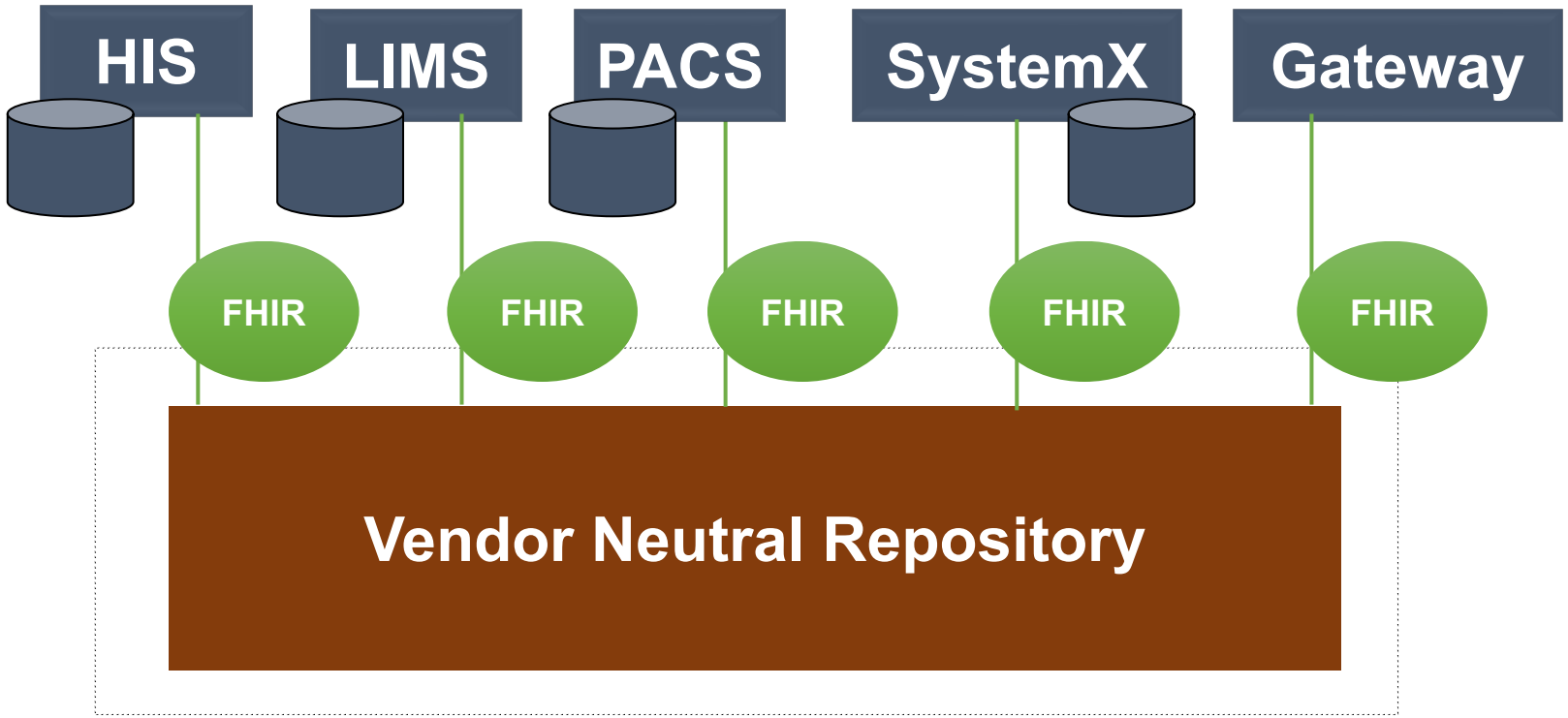
SMART ON FHIR

CDS HOOKS

???

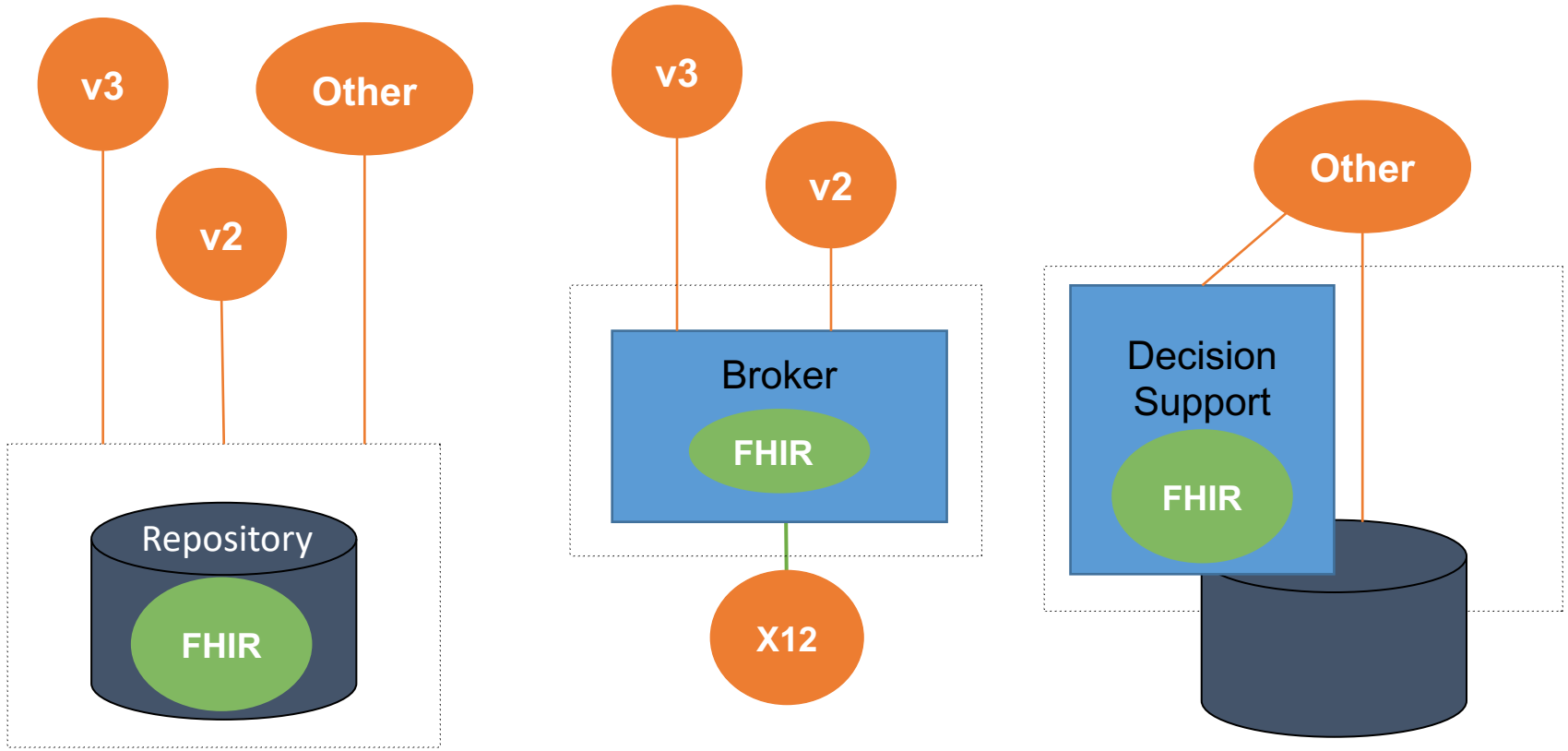
Are CDS Hooks ready for AI BOOM?

Final Considerations



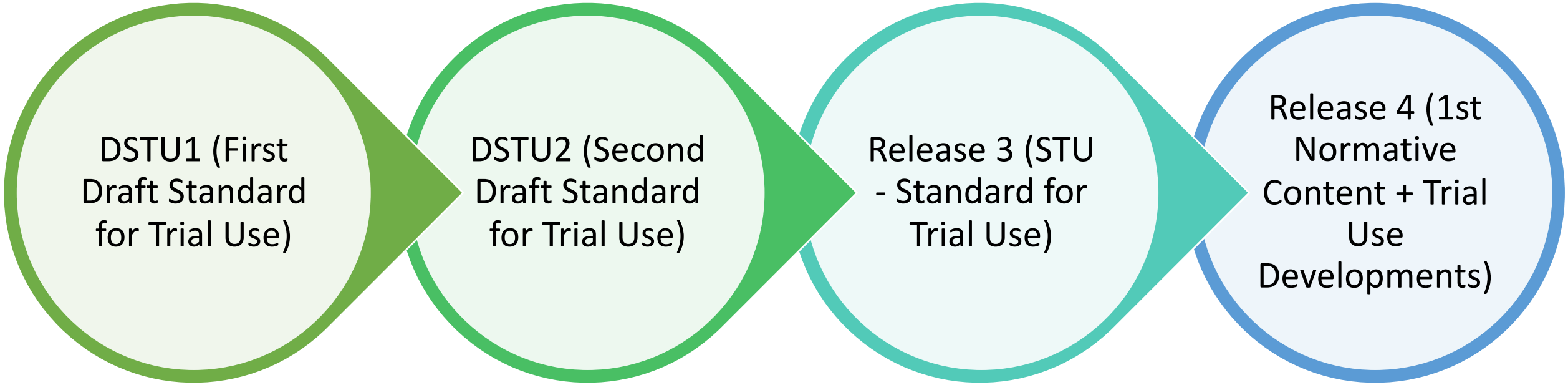
https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

Final Considerations



https://github.com/FHIR/documents/blob/master/presentations/FHIR%20Overview.pptx

What is next?



Join the community – share your experience – improve the standard

R5 is being release in the meantime

Differences?

R4

Name	Flags	Card.	Type
MedicationAdministration	TU		DomainResource
identifier		0..*	Identifier
instantiates	Σ	0..*	uri
partOf	Σ	0..*	Reference(MedicationAdministration | Procedure)
status	?! Σ	1..1	code
statusReason		0..*	CodeableConcept
category		0..1	CodeableConcept
medication[x]	Σ	1..1	
medicationCodeableConcept			CodeableConcept
medicationReference			Reference(Medication)
subject	Σ	1..1	Reference(Patient | Group)
context		0..1	Reference(Encounter | EpisodeOfCare)
supportingInformation		0..*	Reference(Any)
effective[x]	Σ	1..1	
effectiveDateTime			dateTime
effectivePeriod			Period
performer	Σ	0..*	BackboneElement
function		0..1	CodeableConcept
actor	Σ	1..1	Reference(Practitioner | PractitionerRole | Patient | RelatedPerson | Device)
reasonCode		0..*	CodeableConcept
reasonReference		0..*	Reference(Condition | Observation | DiagnosticReport)
request		0..1	Reference(MedicationRequest)
device		0..*	Reference(Device)
note		0..*	Annotation
dosage	I	0..1	BackboneElement
text		0..1	string
site		0..1	CodeableConcept
route		0..1	CodeableConcept
method		0..1	CodeableConcept
dose		0..1	SimpleQuantity
rate[x]		0..1	
rateRatio			Ratio
rateQuantity			SimpleQuantity
eventHistory		0..*	Reference(Provenance)

Documentation for this format

R5

Name	Flags	Card.	Type
MedicationAdministration	TU		DomainResource
identifier		0..*	Identifier
instantiatesCanonical	Σ	0..*	canonical(PlanDefinition | ActivityDefinition)
instantiatesUri	Σ	0..*	uri
basedOn		0..*	Reference(CarePlan)
partOf	Σ	0..*	Reference(MedicationAdministration | Procedure)
status	?! Σ	1..1	code
statusReason		0..*	CodeableConcept
category		0..*	CodeableConcept
medication	Σ	1..1	CodeableReference(Medication)
subject	Σ	1..1	Reference(Patient | Group)
encounter		0..1	Reference(Encounter)
supportingInformation		0..*	Reference(Any)
occurence[x]	Σ	1..1	
occurenceDateTime			dateTime
occurencePeriod			Period
recorded	Σ	0..1	dateTime
isSubPotent		0..1	boolean
subPotentReason		0..*	CodeableConcept
performer	Σ	0..*	BackboneElement
function		0..1	CodeableConcept
actor	Σ	1..1	Reference(Practitioner | PractitionerRole | Patient | RelatedPerson | Device)
reason		0..*	CodeableReference(Condition | Observation | DiagnosticReport)
request		0..1	Reference(MedicationRequest)
device		0..*	Reference(Device)
note		0..*	Annotation
dosage	I	0..1	BackboneElement
text		0..1	string
site		0..1	CodeableConcept
route		0..1	CodeableConcept
method		0..1	CodeableConcept
dose		0..1	SimpleQuantity
rate[x]		0..1	
rateRatio			Ratio
rateQuantity			SimpleQuantity
eventHistory		0..*	Reference(Provenance)

Documentation for this format

To sum up

The importance of standards

What is HL7

What is HL7 FHIR

What is a FHIR Resource

What are Bundles

What are extensions

What are profiles

Cross-sectional collaboration is key

Interoperability

Challenges Day 1

Pedro Marques

eHealth4All@EU – 2022 Porto Summer School

Challenge 1

- Each group will represent an Health Information System developer interdisciplinary team.
- You are now taking a look at **body temperature** registrations.
- The task for Each group is to propose an structure for storage temperature data based on their evidence based interpretation of the concept of body temperature.

Groups

- G1
  - …
- G3
  - …
- G2
  - …
- G4
  - …
- G5
  - …

Challenge 1 cont

- Next you are faced with the need to exchange information with each other.
- Taking your structure create and send a message to the other teams with your registries for temperature.

Challenge 1 cont.

- how well does your solution cope with the incoming messages ?

- You need to design an approach for storing these registries and to guaranty that they can be seamlessly exchanged with other systems.
- What can you do ?
- The final objective is to make every message exchange possible!

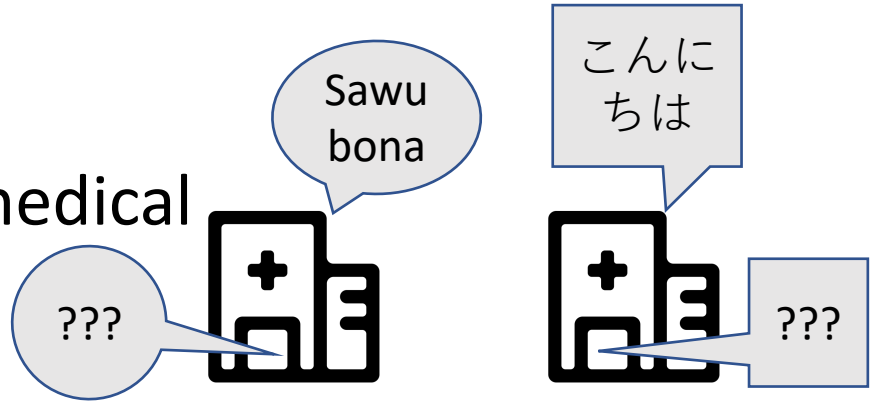
Challenge 2

- There is also the need to exchange the demographic data associated to each register.
- Create an additional description on how it should be stored , how many sub boxes and what shape do they have ?
- Can you accommodate the received messages in your boxes ?

Why do we need standards ?

- When storing or exchanging health data we need
  - Understanding about what the data says
  - Understanding about what the data means
  - Understanding about where the data is
  - Understanding about the context in which the data is collected

- Failure in this understanding may result in a medical error and maybe even death



What is a standard ?

- Standard : A Document developed and used by consensus of the stakeholders which describes how a ”product” is to be obtained or used.

- In the Health information systems context
  - Standards are agreed-upon methods for connecting systems together and managing data.
  - Standards may address different layers of communication from security, data transport, data format or structure, to the meanings of codes or terms laying within the envelope.

Some SDO (Standard developing organizations) involved in healthcare standards definition

- CEN TC251 – European Standards for Health Informatics
- GEHR -> OpenEHR
- WHO – World Health Organization
- HL7 – Health Level 7 International
- ASC X12 – Accredited Standards Committee X12
- IHE – Integrating the Healthcare Enterprise
- ISO – International Organization for Standardization
- DICOM – Digital Imaging and Communications in Medicine
- Regenstrief Institute (LOINC Codes)
- CMS (ICD-10)
- IHTSDO - International Health Terminology Standards Development Organization (SNOMED)

Examples of standards

Main group of standards

- organizational
- semantic aimed standards,
- content aimed standards,
- data exchange or transport aimed standards

- IHE
- Loinc, SNOMED, ICD, openEHR, etc
- HL7 CDA, HL7 v2/3 and FHIR
- HL7 v2, FHIR

How a standard is developed ?

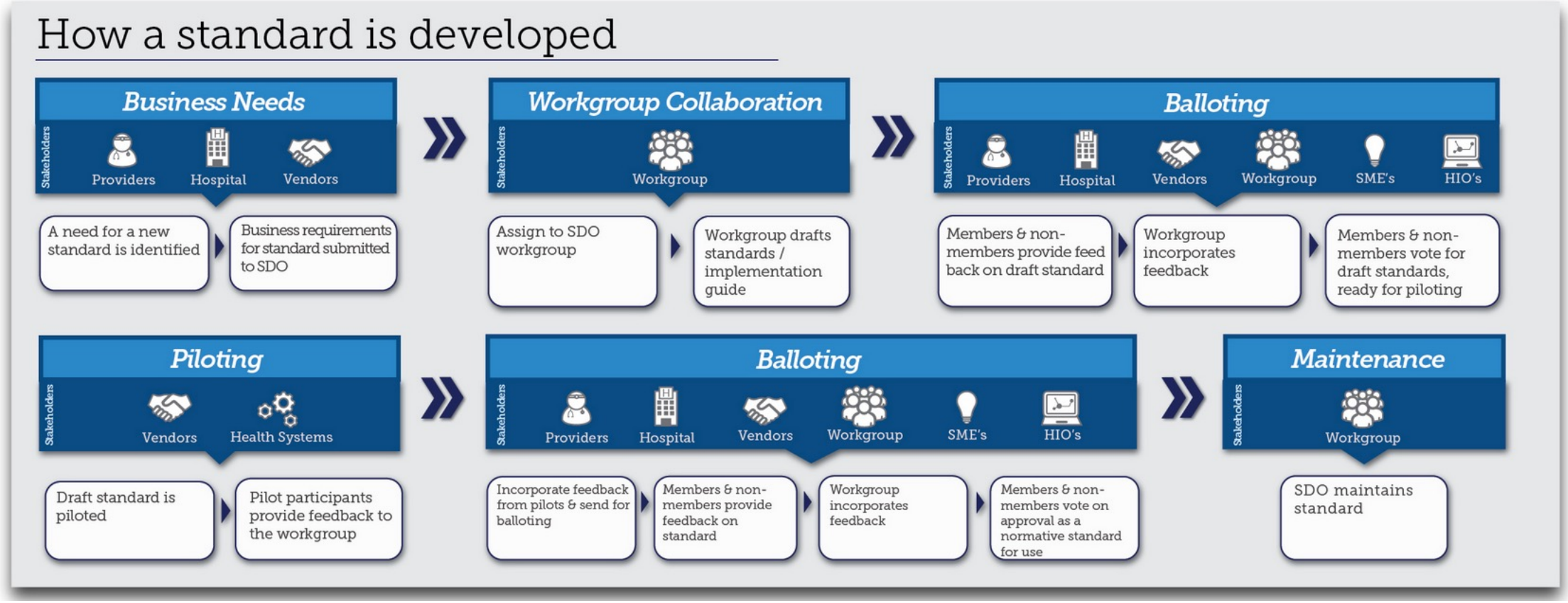


Image available in https://www.healthit.gov/playbook/sdo-education/chapter-2/

Do you already feell like an active member of the eHealth4all standard development committee ?

Challenge 3

- Take in consideration the next case and think about what is the structure for the necessary information so that the systems you own are able to participate in the study and provide data to an external central repository used for research.
- Intended Cohort should include patients that have at least 3 encounters/contacts with health institutions separated by 3 months

Challenge 3

- An international group of doctors and nurses from primary and secondary care wish to improve the management of diabetes patients Type 2 by early detecting patients at risk. They are acquainted with the most recent international studies, however, are interested to see how these findings match the local situation. They plan to issue a customised diabetes programme for their region to enhance the quality of care. They are also interested to find out how the situation is in another European region and want to learn from the doctors and nurses there.

- They intend to develop a new prediction model of someone developing diabetes taking in consideration the available evidence . By now they have identified a couple of relevant information that they think to need to receive for developing this model, additionally there are negotiations on the table for receiving data from the US:
    - Patient Age -
    - Patient Height
    - Patient Weight
    - Patient Gender
    - BMI
    - Blood Pressure
    - Blood Glucose Measurements
    - Cholesterol measurements
    - Medical Diagnoses
    - Nursing Diagnoses / life style related information (activity Level)
    - Nursing intervention: e.g. diet programme for family
    - Active Medication

Interoperability

Challenges Day 2

Pedro Marques

eHealth4All@EU – 2022 Porto Summer School

Challenge 4 – Play with FHIR

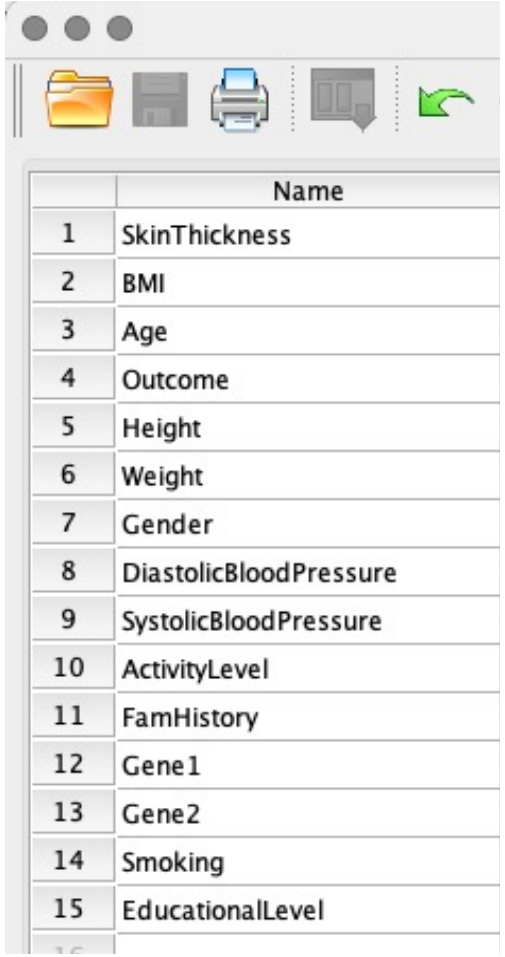
- Identify the FHIR resources needed to represent information about these situations:
  - A person followed on an Health Institution.
  - Patient named *John Cooltrain* got a prescription of 1 tablet of **Cyclizine** two times a day on July 17, 1967.
  - Collecting *Glasgow Comma Score* through an online form.
  - Information about Doctors and Nurses working at the hospital.
  - Whether a citizen has taken COVID-19 vaccine.
  - Who delivered more babies in *The More The Merrier Hospital*

Challenge 4 – Play with FHIR

- Identify the FHIR resources needed to represent information about these situations:
  - A person followed on an Health Institution.
    - Person/Patient/Organization
  - Patient named *John Cooltrain* got a prescription of 1 tablet of **Cyclizine** two times a day on July 17, 1967.
    - Patient/Medication/MedicationStatement/
  - Collecting *Glasgow Comma Score* through an online form.
    - Patient/Questionnaire/QuestionnaireResponse
  - Information about Doctors and Nurses working at the hospital.
    - Practicioner/PractitionerRole
  - Whether a citizen has taken COVID-19 vaccine.
    - Patient/Immunization
  - Who delivered more babies in *The More The Merrier Hospital*
    - *Patient/Praticioner/Procedure/Organization (https://informatiestandaarden.nictiz.nl/wiki/Gebz:V1.1_FHIR_IG)*

Challenge 5 – Play with FHIR

- Take in consideration the case described in Challenge 3 and that you want to build the SPSS table on the right, identify the necessary FHIR resources that could be used.
- Identify for each resource the mandatory fields
- Notes: You are also receiving information from the US



	Name
1	SkinThickness
2	BMI
3	Age
4	Outcome
5	Height
6	Weight
7	Gender
8	DiastolicBloodPressure
9	SystolicBloodPressure
10	ActivityLevel
11	FamHistory
12	Gene1
13	Gene2
14	Smoking
15	EducationalLevel

Challenge 6 - Create with FHIR

- http://clinfhir.com/
  - Graph Builder http://gb2.clinfhir.com/ to create your resources online
  - Patient Viewer http://clinfhir.com/patientViewer.html

- https://lhcforms.nlm.nih.gov/fhir/research-data-finder/
  - Data Extraction

clinFhir Hints

- GraphBuilder
  - Create a new Project
  - On the server , select costum
    - https://lforms-fhir.nlm.nih.gov/baseR4
  - Enter your project
  - Use the Add a new resource instance to add new resources
  - Double click on the resource (rectangle) in the central area to open the detail view.
  - Save to Server (left menu)
  - Use the Audit to check your resources.

clinFhir hints

- http://clinfhir.com/patientViewer.html
- Use the same server.
- Select your patient

Data extraction

- https://lhcforms.nlm.nih.gov/fhir/research-data-finder/
  - Define Cohort
  - Define Criteria
  - Search
  - Pull Data

Solution Chalenge 1

Description	Type
Value	Numeric
Unit	Text
Location	Text / Code
Type of Device	List

Refs: https://www.ncbi.nlm.nih.gov/books/NBK331/

So

Type of Information	Resource / Field
Patient Age -	Patient.birthDate
Patient Height	Observation (http://hl7.org/fhir/observation-example-body-height.json.html)
Patient Weight	Observation (http://hl7.org/fhir/observation-example.json.html)
Patient Gender	Patient.gender
BMI	Observation (http://hl7.org/fhir/observation-example-bmi-using-related.json.html)
Blood Pressure	Observation with components (http://hl7.org/fhir/observation-example-bloodpressure.json.html)
Blood Glucose Measurements	Observation (http://fhir-ru.github.io/observation-example-f001-glucose.json.html)
Cholesterol measurements	Observation for each nad also can be used within a diagnostic report dor lipidic measurements (https://fhir-ru.github.io/diagnosticreport-example-lipids.json.html)
Medical Diagnoses	Observation / Condition
Nursing Diagnoses / life style related information (activity Level)	Observation / Use ICNP terminology for classification
Nursing intervention: e.g. diet programme for family	Procedures / Use ICNP terminology for classification
Active Medication	MedicationStatement with the status query parameter set to active,intended

Appendix II: Data Protection and Security

Presentation: Data protection and security

Presentation: Data protection and security – case learning 2022

Data Protection and security Summer school in Porto

Tiina Haukkakallio 2022

Tiina Haukkakallio

- Project researcher at University of Eastern Finland
- Data Protection officer @ Päijät-Häme social and healthcare joint authorotie
  - 200 000 customers
  - 8000 employers

Education:

- Studying master of human and health informatics management
- Master of public health
- Teacher
- Registerd nurse

Content

- Key concepts
- Legislation
- Actors and roles
- Skills
- Information security
- Ethics
- Consent

Teamwork: cases

Data protection

- Is a fundamental right that safeguards the rights and freedoms of data subjects with regard to the processing of personal data;
- taking into account the legal regulations and requirements governing the processing of personal data in order to ensure the privacy and legal protection of each person;
- requires the planning, operation, monitoring, guidance and continuous training of data processing;
- The privacy management model is in place and up-to-date

Data protection

- the implementation of data protection laws is steered and supervised by the Data Protection Ombudsman, instructions by the Office of the Data Protection Ombudsman (www.tietosuoja.fi)

Legislation:

- REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL EU General Data Protection Regulation and language versions
- Data Protection Act 2018/1050, supplements the EU's General Data Protection Regulation and this Act repealed the Personal Data Act 1999/523, the Data Protection Act entered into force on 1.1.2019

  - Act on the Processing of Personal Data in Criminal Matters and in Connection with maintaining National Security 2018/1050, entered into force on 5.12.2018
  - Act on the Electronic Processing of Customer Data in Healthcare and Social Welfare 2021/784
  - Act on Electronic Prescriptions 2007/61
  - Health Care Act 2010/1326
  - Act on the Status and Rights of Patients 1992/785

Why **General Data Protection Regulation** is needed?

- Rapid development of technology and
- globalization
- electronic services, data collection, remote and mobile use of information systems,
- organizational collaboration and outsourcing of services,
- software robotics,
- cloud services and
- artificial intelligence

Why **General Data Protection Regulation** is needed?

- Differences in the processing of personal data between EU countries
- The goal is to make the rights of the data subject more comprehensive

- The Regulation applies for the processing of personal data when personal data **constitutes a register** or are intended to form part of a register (for example information system is a Patient Register)

Digitalisation

- In social and health care more common over the past years.
- Some people use digital applications/services, especially in the health care sector.
- For everyone digital services are not possible to use.
- There is big differences in skills between people.
- **Challenge in the coming years** seems to be how to increase the content or quantity of digital.
- Challenge is also that everyone is capable of usein digital services.

Data processing in healthcare

- The processing of personal data requires a basis for processing in accordance with Article 6 of the GDPR.
- In healthcare, the primary processing of a patient's data is based on the following processing legislation:

1. the patient's consent (Article 6(1)a),
2. the legal obligation of data controllers (6(1)c),
3. the protection of the vital interests of a natural person (6(1)d) or
4. the performance of a task carried out in the public interest (6(1)e).

Trust

- Where trust comes from?
- the information is accessible to those entitled to use it, in accordance with agreed procedures, is not disclosed or brought to the attention of third parties;
- all users of the patient records can always be identified and, at the same time, their right to process data can only be determined to the extent required by their work tasks and responsibilities. (Ritva Karjalainen-Jurvelin)

Confidentiality

- only users that have a legal right to see, modify, destroy or otherwise manipulate a document or information
- The importance of data protection and information security in social and health care Requirements :
  - maintain a confidential patient/client relationship
  - support customer/patient-oriented thinking
  - combine the rights of both the controller and the data subjects/patients
  - protect sensitive information from third parties
  - to support the legal protection and skills of professionals.

(Ritva Karjalainen – Jurvelin, Tietosuoja.fi)

Patient`s rights

- healthcare, the patient's sensitive information is treated confidentially and in compliance with professional secrecy.
- Trust between the data subject and the controller is realised through good personal data processing practices.
- The purpose of the GDPR is also to enable the free movement of data within the European Union. (2016/679.).

- (Tietosuoja.fi)

Patient`s rights

- In health care, data concerning special categories of personal data, i.e. health data, are processed. (General Data Protection Regulation (2016/679) Art. 9)
- Data protection and security are important in healthcare because the health data being processed is sensitive of a person's privacy.
- only those persons who have the legal right to process personal data process the data. (Patient Act 785/1992, Act on the Openness of Government Activities 621/1999)
- Patients are informed about the organisation's processing of personal data. (Ritva Karjalainen-Jurvelin)

Patient`s rights

- The EU's General Data Protection Regulation sets down patient rights when a company or organisation is processing personal data.
- have the right
  - to obtain information on the processing of your personal data
  - of access to your data
  - to rectification of your data
  - to the erasure of your data and to be forgotten
  - to restrict the processing of your data
  - to data portability
  - to object to the processing of your data
  - not to be subject to a decision based solely on automated processing. (Tietosuoja.fi)

Office of the Data Protection Ombudsman

- The Data Protection Ombudsman is a national supervisory authority which supervises the compliance with data protection legislation. With Data Protection Ombudsman and two Deputy Data Protection Ombudsmen there works approximately 45 specialists in the office.
- The Data Protection Ombudsman is an autonomous and independent authority who are appointed by the government. Their term of office is five years.
- **Sanctions Board**
- The Data Protection Ombudsman and deputy data protection ombudsmen form the Sanctions Board tasked with imposing administrative fines in accordance with the General Data Protection Regulation. The Board is chaired by the Data Protection Ombudsman.

Controller

- A person, company, authority or entity that determines the purposes and means of the processing of personal data is called a controller.
    - Healthcare authority

Data processor

- A data processor is a third party from the controller that processes personal data on behalf of the controller.
  - When controller is outsourcing it`s services

Data Protection Officer

- is involved in the processing of all questions concerning the protection of personal data the data protection officer shall be 'duly and in a timely manner involved in all matters relating to the protection of personal data'.
- As regards data protection impact assessments, the GDPR explicitly provides for the early involvement of the DPO and specifies that when carrying out such an impact assessment, the controller must seek advice from the DPO

Data Protection Officer

- The DPO shall be regularly invited to meetings of senior or middle management.
- His presence is advisable when making decisions that have an impact on data protection.
- All relevant information shall be provided to the Data Protection Officer without delay so that he or she can give appropriate advice.
- The opinion of the data protection officer shall always be given due weight. In the event of a disagreement, the Working Party recommends documenting as good practice the grounds for not following the advice of the Data Protection Officer.
- The DPO is consulted quickly in the event of a personal data breach or other problem.

Data Protection Officer

- Instructions and capabilities to "perform their duties and tasks independently" Article 38(3) of the GDPR establishes some basic safeguards to ensure that the DPO can perform his or her tasks within the organisation with sufficient independence.
- In particular, controllers or processors shall ensure that the data protection officer does not 'take instructions in the performance of [his or her] duties'.

Data Protection Officer

- the implementation of data protection laws is steered and supervised by the Data Protection Ombudsman, instructions by the Office of the Data Protection Ombudsman (www.tietosoja.fi)

Data Protection impact assesment

Data Protection Officer estimates with professionals:

- Is there a need to do data protection impact assessment?
- Application and software risk management
- What other risks has to estimated?
- what safeguards (including technical and organisational measures) should be put in place to reduce the risks to the rights and interests of data subjects;

- 35 Article 39(1)

DPO

- In organization the DPO has to be informed and consulted the GDPR (data processing)
- Consulting DPO has to be standard procedure in organization.
- it is important DPO belongs to the working groups that deal with the data processing issues of the organization.

Personal data

- Name, personal ID, location information,
- Physical,
- physiological,
- genetic,
- economic,
- cultural or social factor

Personal Data Processing

- Personal Data Processing is legal, reasonable and transparent
- What information is collected and how the data is collected?
- purpose limitation

Personal Data Processing

- Collecting
- Recording
- Organizing
- Usage
- Moving
- Releasing
- Retaining
- Changing
- Merge
- Protecting
- Deletion

Register

- “register" means any set of data containing **structured personal data** for which data are available on a given basis,
- whether the data set was then centralized,
- decentralized or distributed on a functional or geographical basis;

Logging information

- Data is stored for a limited time
- Patient information 12 years from death or 120 years from birth
- logging information for 12 years from event creation

Data Processing

- Collecting data for a specific, explicit and legitimate purpose (Health Care Act, Patient Status and Rights Act)
- Information may not be used for **any purpose other** than that for which it was collected

Data Processing

- Minimize data
- Only relevant information is collected
- The information is correct
- The information is accurate
- Updating patient data if necessary
- Incorrect and inaccurate information is corrected

Data Processing

- They must not be uncontrollably exposed,
- modified or destroyed as a result of inappropriate action,
- hardware or software malfunction, malware or any other incident or disruption.

Data Processing

- Patient can trust that her data is safe and used only when there is legal right

- Quality of healthcare work is improving

Healthcare Professional

- Knowledge enhances patient security
- Employee`s own privacy will improve
- job satisfaction improves
- competence also benefits other areas of life

Healthcare organization

- Quality improves
- Trust to health business is improving
- Productivity enrises
- Risk are minimized
- Supervisory authority are happy with our work

Procurement contracts

- Procurement contracts play an important role in the implementation of data protection and security in an organization
- When using cloud services, is there a need to protect the privacy of the country (where the servers are located?)

Key principles of information security:

- Usability of information
- information is available whenever it is needed within a predefined response timeframe
- affected hardware and software with which the data is processed Data integrity
- immutability of information when processing and transmitting data from one place to another or during archiving

Data security:

- protecting privacy,

  including the preservation of the integrity of the quality and integrity of data and the protection by technical means;
- preparing for personal data breaches and cyber incidents,
- implementing information security,

  such as securing premises, continuity planning and risk management;

Risk based thinking

Risk based thinking

This means that in organizations activity,

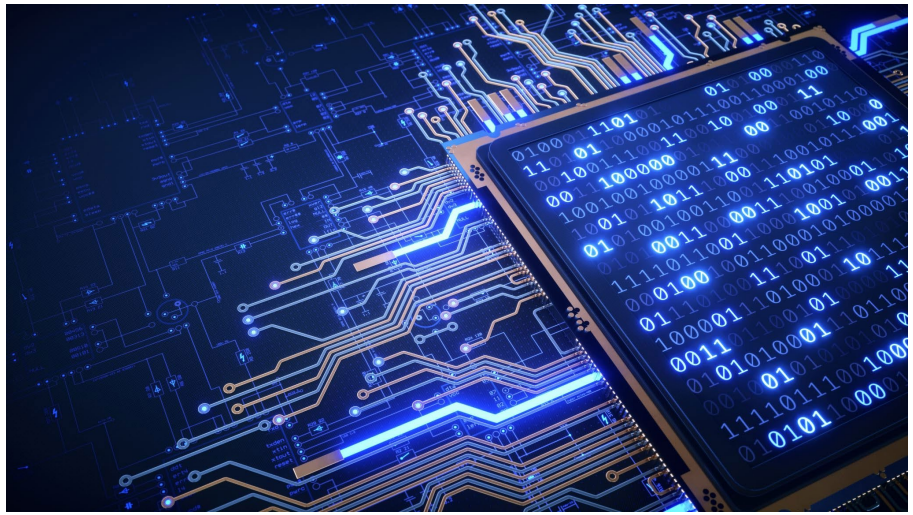
risk based thinking is related to data **confidentiality,**

integrity and availability are taken into account.”

(Ministry of finance “Personnel Information Security Instructions”)

Risk based thinking

- We have to think risk when we are useing new technology in healthcare.
- We have to think risk
- For example when useing technical devices in patient care
  - AI
  - applications



Digi-HTA assessment (Health technology)

- Finland`s Ministry of Social Affairs and Health recommendation
- provides a reliable and impartial assessment of the suitability of a company's product to support decision-making.
- The recommendation process is becoming established as a national activity for digital solutions in healthcare. <="" p=""> The company produces information about its own product using questionnaires.
- The amount of work required is approximately one working day. Conducting an assessment opens up an opportunity for the company to develop the service and self-evaluate.
- Healthcare organization needs only require a Digi-HTA assessment from the company,
  - for example, when conducting a market survey, before procurement, in connection with a procurement or when starting a piloting of services.
- Healthcare organizations can also use existing Digi-HTA recommendations.
- is based on the information provided by the company about its product and includes also a literature review.

(https://thl.fi/fi/tutkimus-ja-kehittaminen/tutkimukset-ja-hankkeet/hyvinvoinnin-tekoaly-ja-robotiikka-ohjelma-hyteairo-/digi-hta

Digi-HTA assessment (Health technology)

- recommendation is issued for the product.
  - The Digi-HTA criteria and assessment process are suitable for the assessment of digital medical devices for healthcare and well-being, as well as digital non-medical devices/solutions.
- MDD/MDR guarantee CE marking (marketing authorisation in the EU),
- provides information on the product's:
  - effectiveness
  - costs
  - safety
  - usability and accessibility
  - information security and protection
  - details that should be taken into account when implementing the product (e.g. required care process and IT changes, integration with other systems, product support, training, etc.).

(https://thl.fi/fi/tutkimus-ja-kehittaminen/tutkimukset-ja-hankkeet/hyvinvoinnin-tekoaly-ja-robotiikka-ohjelma-hyteairo-/digi-hta)

Internet use

- healthcare providers are increasingly offering e-services instead of traditional services.
- In 2020 as much as 64 percent of the population had used Finland's national medical record service for the citizens (My Kanta Pages) and
- every fifth had met a healthcare or social welfare professional online during the past 12 months

Internet use

- In Europe, only in the other Nordic countries and the United Kingdom, internet use is more common than in Finland, but the differences at the top are small.
- It is worth noting that although internet usage in Finland is common and the Internet is used by almost all Finns, there are also many differences in the use of the network.
- Many Finns also have significant problems in adopting the new services of the network, and the level of education and social status affect how the network is used, for example.
- digital divide still exists in Finnish society as well, and digitalisation also creates and strengthens social inequalities.

Data breach

- Person can loss her: identity, money, sensitive information, reputation

- It is important that people can trust health care eServices
- Digital litteracy, abilty to use and understand technology, education
- digital skills, keep up with development of digitalization, technology
- Understand risk management, where and to whom I share my information
- When health care professionals are skilled in technology use and they are capable to teaching people -> helps people to use technology

- With digitalisation, cybersecurity skills have become civic skills.
- With these skills, society of Europe and whole world remains safe for everyone.
- Carefree behaviour can, in the worst case scenario, cause considerable harm and even danger.
- For this reason, cybersecurity behaviour protects not only itself, but also, for example, one's loved ones, their employer and society as a whole.

Cyberworld

- We are all responsible for ensuring that we are having a cybersecurity society.
- We must take care of the digital security of society as a whole, both in terms of competence and practical activities.
- With the following 10 cyber commands, you can check if your and your loved ones' digital security is at an adequate level and, if not, what can you do to rectify the situation.

Teach and guidance people in cybersecurity issues

Most effecitive is to prepare before data breach happens

- Update your divice
- Ask why I get this message or link
- Create strong passwors, usernames safety,

Advice and guidance for victims of data breaches Finland we have data breach support internetsites

- People get guidance
- Helpful links to websites of authorities and organisations
  - Police, National cyber Security Center, Valvira,

Dataprivacy, impact assessment is part of acquistion

new acquisition

acquisition includes new technology, profiling

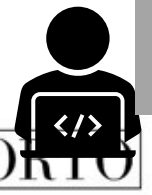
impact assessment, risk mitigation plan and action

if the residual risk is high, a request for prior consultation shall be made to the Data Protection Officer

No impact assessment

Acquistion agreement and data protection agreements

Contact dataprivacy team



The purpose of a data protection impact assessment is to identify, assess and manage the risks associated with the processing of personal data

Remote care, telehomecare, telecare telenursing, telemedicin

- is a method of delivering healthcare services that uses technology.
  - It is executed by a professional,
  - it has a clear goal,
  - happens in a certain time period.

(Reference: sotepeda material.)

Ethics

- *Ethics*, also called moral philosophy, is the discipline that concerns what is morally good and bad and morally right and wrong.
- All technological solutions, including telecare, have their ethical aspects. These aspects include, for example:
  - administrative regulations
  - telecare accessibility
  - clients' self-determination
  - data security
  - privacy
  - client verification
  - professional competence in technology and guidance via networks

(Reference: sotepeda material.)

Data security and privacy in telemedicin

- All interactions with clients that are text- or video-based can leave behind evidence of their health information.
- Professionals and organizations in social and health care must guarantee the security and privacy of clients' protected health information, including:
  - the information security of the *network*
  - the security of *communication applications*
  - the security of *data terminal equipment*
  - the security of the *environment* where patient information is used
  - the information security of the *service provider*

(Reference: sotepeda material.)

Informed consent

- Potential issues that can arise in telecare should be discussed in informed consent documents.
- Patients should always sign an informed consent form before telecare.
- The information should include:
    - technology use policies
    - social media policies
    - confidentiality issues
    - acknowledgement of limitations of services
    - the risks and benefits of using technology
    - anticipated response time
    - possible technological failures and alternative methods of communication

(Reference: sotepeda material.)

Education & Training

- Professionals must evaluate clients' cognitive, motor and perceptual skills and the possibilities to use technology needed in telecare.
- Professionals are responsible for the use of technological applications and devices efficiently and safely.
- Professionals must get further education if needed.

Education & Training

- Professionals should seek training on how to develop a therapeutic relationship through telecare.
- There is little to no evidence that telecare would negatively affect the relationship between the client and the professional.
- Professionals should give clear information and guidance about technical devices to the client.
- Clients need to know from whom they can obtain consultation if needed.

(Reference: sotepeda material.)

summary

- In the curricula of social and health care professions there should be education about telecare and ethical issues.
- Professionals should update their technological and ethical know-how.
- The values and principles of an organization must be taken into account in telerehabilitation services, and the quality of the service must be as good as in face-to-face therapy.
- Because interventions can be delivered in the natural environment at a client's home, telecare may increase patient participation and enhance outcomes beyond face-to-face care.
- Telecare may decrease costs both for a client and for a care organization and also increase geographic accessibility.

(Reference: sotepeda material.)

Consent of the data subject

- Consent is one possible legal basis for processing personal data.
- Consent gives the data subjects the opportunity to evaluate the processing of their personal data,
- influence it by withdrawing their consent.
- **Requirements for consent,** For consent to be valid, it must be a
    - informed,
    - freely given,

    - Data subjects can give their consent for predefined, specific and lawful purposes.
    - If the purpose of processing personal data changes, you need to ask for a new consent before starting processing.

(references: Tietosuoja.fi)

Specifying the consent

- When you are asking for consent, you need to specify the purpose for which data is being collected.
- If personal data is processed for several purposes,
  - data subjects must be able to choose the purposes for which they wish to give their consent.
- consent must be asked separately for each purpose.
- It is always required to ask for consent when starting processing personal data for a new purpose.

(references: Tietosuoja.fi)

Freely given consent

- Consent is not genuinely freely given if the data subject is in a vulnerable position in relation to the controller.
- Data subjects can be in a vulnerable position when, for example, the controller is their employer or an authority.
- Data subjects must be able to refuse consent and withdraw it without any detrimental consequences.
- To withdraw consent has to be as easy as to give it.

- (references: Tietosuoja.fi)

Accountability and consideration of the principles of data protection

- Organization has to be able to demonstrate that the data subjects have given their consent to the processing of personal data,
- also that the given consent fulfils the legal requirements.
- Consent can never override the principles of data protection.
  - For example, you cannot collect data more extensively than necessary for the stated purpose or deviate from the obligation to protect personal data.

- (references: Tietosuoja.fi)

Asking for consent

- Consent is an clear expression of the data subject's wishes, by which he or she accepts the processing of his or her personal data.
  - Data subjects cannot give their consent through silence, pre-ticked boxes or inactivity.
- If organization requests consent electronically,
  - the request must be clear and
  - it may not needlessly disrupt the use of the service.
  - For example, ticking a box on a website is a sufficiently clear expression of wishes.
- consent has to ve clearly and separately from other information.
- consent should not be linked to terms of use or agreements
    - so that the data subject will not have a genuine opportunity to give or refuse consent.
  - Consent has to ve separately from other information
  - in clear and plain language and

(references: Tietosuoja.fi)

What do you need to tell data subjects when asking for consent?

- When asking for the consent of data subjects for the processing of personal data, you are required to inform them of, at minimum:
  - the controller or controllers (joint controllers) and any other parties to whom the data will be disclosed
  - all of the specific purposes for which the consent is being requested
  - what data will be collected from the data subject
  - the data subject's right to withdraw consent
  - the use of the data for automated individual decision-making and profiling and
  - the risks of data transfer to countries outside the EU,
    - if a decision on the adequate level of data protection in the country has not been given and appropriate safeguards have not been implemented.
- (It is not necessary to identify the processors that will process the personal data on behalf of the controller when asking for consent. In connection with asking for consent, however, you also need to take the more general obligation to provide information and the information you will need to provide when collecting personal data from the data subjects. The general obligation to provide information requires the recipients of the data to be specified, including the processors working on behalf of the controller.) (references: Tietosuoja.fi)

When will I require the data subject's specific consent for processing personal data?

- Specific consent can be used as a legal basis when:
  - you are processing special categories of personal data (such as health information or ethnic origin)
  - you are transferring personal data to third countries or international organizations
  - organization`s processing includes automated individual decision-making or profiling.
  - organization`s obligations as a controller increase with the risks involved in the processing of personal data

(references: Tietosuoja.fi)

Withdrawal of consent

- Before the data subject gives his or her consent, the controller must inform the data subject of
  - the right to withdraw consent; and
  - how consent can be withdrawn in practice.
  - It shall be as easy to withdraw consent as to give it. The consent can be withdrawn at any time, for free.
  - If a data subject withdraws his or her consent:
    - Organization is required to stop processing his or her personal data insofar as the processing has been based on consent.
    - Inform data subjects of all bases for processing, so that they will know how the withdrawal of consent will affect the processing of their personal data.
  - Unless there is another legal basis for continuing to store the data processed on the basis of consent, erase it after consent has been withdrawn.
  - When the processing of personal data has ended, keep the proof of consent only for as long as necessary for the establishment,

(references: Tietosuoja.fi)

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- Pictures:Lappalainen Hanna-Leena, Pixabay, Voimala.

Teams and Cases

Team 1: Cybersecurity how to prepare advance to data breach?

- Risk management
- employee perspective
- organizational perspective
- customer perspective

Team 2: How to take in use artificial inteligence

- Health technology
- What to take in to consideration
- IMIA recommendations

cases

Team 3:

What are the things to consider when disclosing patient data between organizations?
What legislation should be taken into account?

Team 4:

What are the ethical and legal rules and regulations of sharing the data for the primary use between the institutions? What role played the secure way they were stored, retrieved and transmitted?

Team 5:

Is patient's informed consent necessary for secondary use of data? Find out from act what a consent has to include?

Team 6:

How to take in use new software? What issues has to be taken into consideration?

(Give examples from 3 countries of how the data can be re-used for secondary purposes, and how does regulation permit and/or forbid it.)

Power point -presentation

- 15 minutes presentation
- Describe the main points of what data protection issues should be taken into account
- Include legislation in your country
- Find evidence based information about your case

Data Protection and security

Case learning 2022

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UNIVERSITÄT OSNABRÜCK

HOCHSCHULE OSNABRÜCK

UNIVERSITY OF EASTERN FINLAND

Tiina Haukkakallio

- Data Protection officer @ Päijät-Häme social and healthcare joint authorotie
- 200 000 customers
- 8000 employers

Education:

- Studying master of human and health informatics management
- Master of public health
- Teacher
- Registerd nurse

Teams and Cases

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Power point -presentation

- 15 minutes presentation
- Describe the main points of what data protection issues should be taken into account
- Include legislation in your country
- Find evidence based information about your case

Porto Summer School 2022 – aim and background

- With the advent and diffusion of electronic health record systems a wealth of patient has become available. In principle, these data can now be shared among the relevant care provider to ensure continuity of care across shifts, departments, institutions, settings and countries. Furthermore, they can be analysed for secondary use particularly for generating new knowledge, for quality development and for management purposes such as resource management. While these new opportunities promise improvements at all levels there are barriers to put the new digital scenarios into practice.

- Many digital patient data are hidden in pdf documents in an unstructured and not machine-readable way. They can be shared digitally among the providers but cannot be analysed without additional efforts. To this end, the data have to be structured, coded and classified according to standards that are common in the national and international community. Thus, in order to share data, the information systems have to ensure full interoperability.

- Apart from the technical access to patient data through interoperable systems, there is the question of the legal foundation of accessing and sharing data. Patient data are personal data and highly sensitive. They are subject to data protection compliant with the European General Data Protection Regulation and other regulations, e.g. obligation to secrecy of health professionals. At the same time data must be securely managed so that they are integer, i.e. free from being manipulated or destroyed, and available for those who are entitled to access them.

- Given the technical and legal accessibility of data, they can be shared and analysed. The opportunity to analyse data is strongly associated with the concept of a Learning Health System (LHS). An LHS is meant to support the generation of new knowledge including the verification of knowledge with local or regional data. Such new insights can be employed for quality management, process optimization, resource allocation and research. An LHS makes use of these findings by drawing conclusions and implementing change. This circumstance leads to new data that then can be further analysed and interpreted.

- The aim of the summer school is to gain insight into two main elements of digital health, I.e. interoperability and data protection/security so that secondary data analyses can be performed. Furthermore, it is the aim to develop a statistical model and hereby understand why data must be comparable and informed consent is imperative.

Data protection and security

- Although both institutions have obtained a written informed consent for primary use that the data can be used and shared across settings for the sake of patient care. There is doubt that this holds totally true for the secondary use, such as knowledge generation, care process development, of data on both institutions. Both institutions try to obtain an informed consent retrospectively from the patients. In those cases where the patients still see the doctor or nurse regularly this was no problem, in cases where the patient moved away or does not come any longer, it became difficult if not impossible to reach out for consent. There was another problem concerning the purpose of the secondary use. While it was clear that the analysis aimed at improving an early detection programme for patients at risk, there were also several other aims which could not be phrased so strictly. These aims were fuzzier and more explorative.

- What are the ethical and legal rules and regulations of sharing the data for the primary use between the institutions?
- What role played the secure way they were stored, retrieved and transmitted?
- Give examples from 3 countries of how the data can be re-used for secondary purposes, and how does regulation permit and/or forbid it.
- Is patient's informed consent necessary for secondary use of data?

Appendix III: Data Analytics

Module Description Data Analytics

Miro-Board (Screenshot)

Presentation: The Learning Health System

Presentation: Clinical Data Analytics: From Data to Knowledge

Module Description

Title: Data Analytics – Investigating Diabetes Risk Factors
Date / Time: Monday 14:00 – 17:30, Tuesday 9:00 – 16:30
Lecturers: Jens Hüsers, Ursula Hübner, Nicole Egbert

Background: Today, health data is available in electronic health records, digital biobanks, and epidemiological registries. This health data is just waiting for researchers to gain insights into the invaluable information and knowledge they contain. Analytical skills are the keys to what keen researchers should be equipped with to unlock the knowledge in the data.
In this course, we teach you those skills by showing you how to think about health data, their potential information, and how to unlock the knowledge. For a deep and sustainable learning experience, you will also apply those analytical tricks to data in actual use cases.

Objectives / Learning Outcomes:

After the course, you will better understand how researchers like you generate clinical knowledge and evidence from health data using analytical and statistical techniques. And you even will get proficient in planning and conducting your own data projects in health research. Specifically, you will know what type of knowledge you can generate from health data, and you will learn how to apply analytical methods for knowledge generation, such as statistical models.

After the course, you are able

- to perform data pre-processing based on a practical example
- to develop a statistical model that allows the analysis of patient data
- to interpret the findings from applying the statistical model and to devise a concept for changing the practice of patient care

Methods:

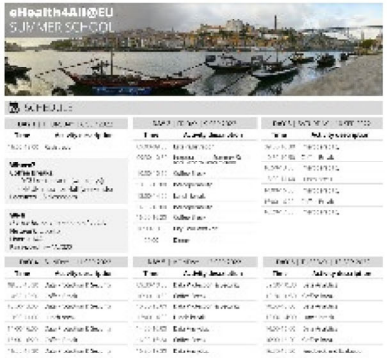
Before the start of the course, you will have access to self-paced learning materials such as videos and quizzes that help to enter the field of data analytics and statistical modelling. Short lectures with room for questions and discussions will be given during summer school. After that, you will apply your learnings on clinical use cases in peer groups that are supported by the teaching staff that is available if you have any questions.

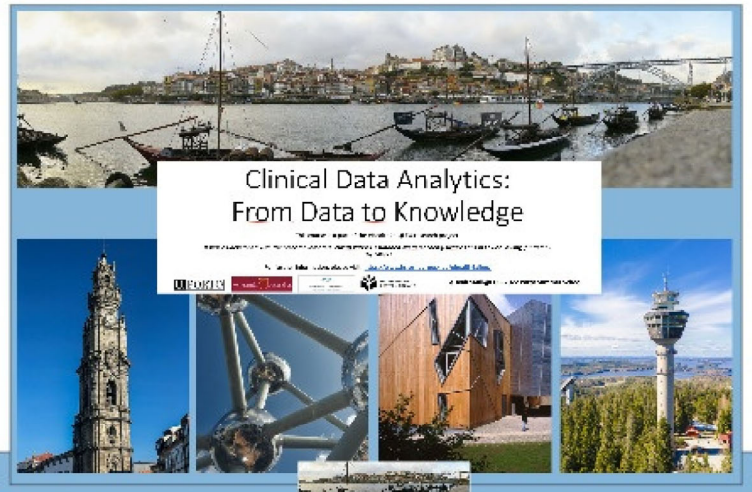
Presentation / Discussion:

In a final presentation, you will show your results. After that, we will mutually discuss your work, providing feedback on your progress and learnings.

Preparation / Online Material:

You will have access to short video lectures and online quizzes to test your knowledge on the lectures content.





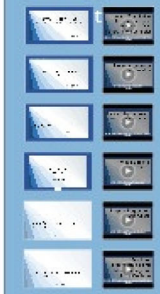
17p1en@med.up.pt
fmup#2020#

Slides

Materials

drive.google.com
diabetes-summer-school.sav

Additional Youtube Content and Slides



Group Osnabrück

Diogo
Hannah
Marie
Anne

Group Porto

Mariana
Anna
Jana
Alberto

Group Kuopio

Marjo
Milla
Lea
Johanna

Group Zoom

zoom

Yusda

With the support of the Erasmus+ Programme of the European Union

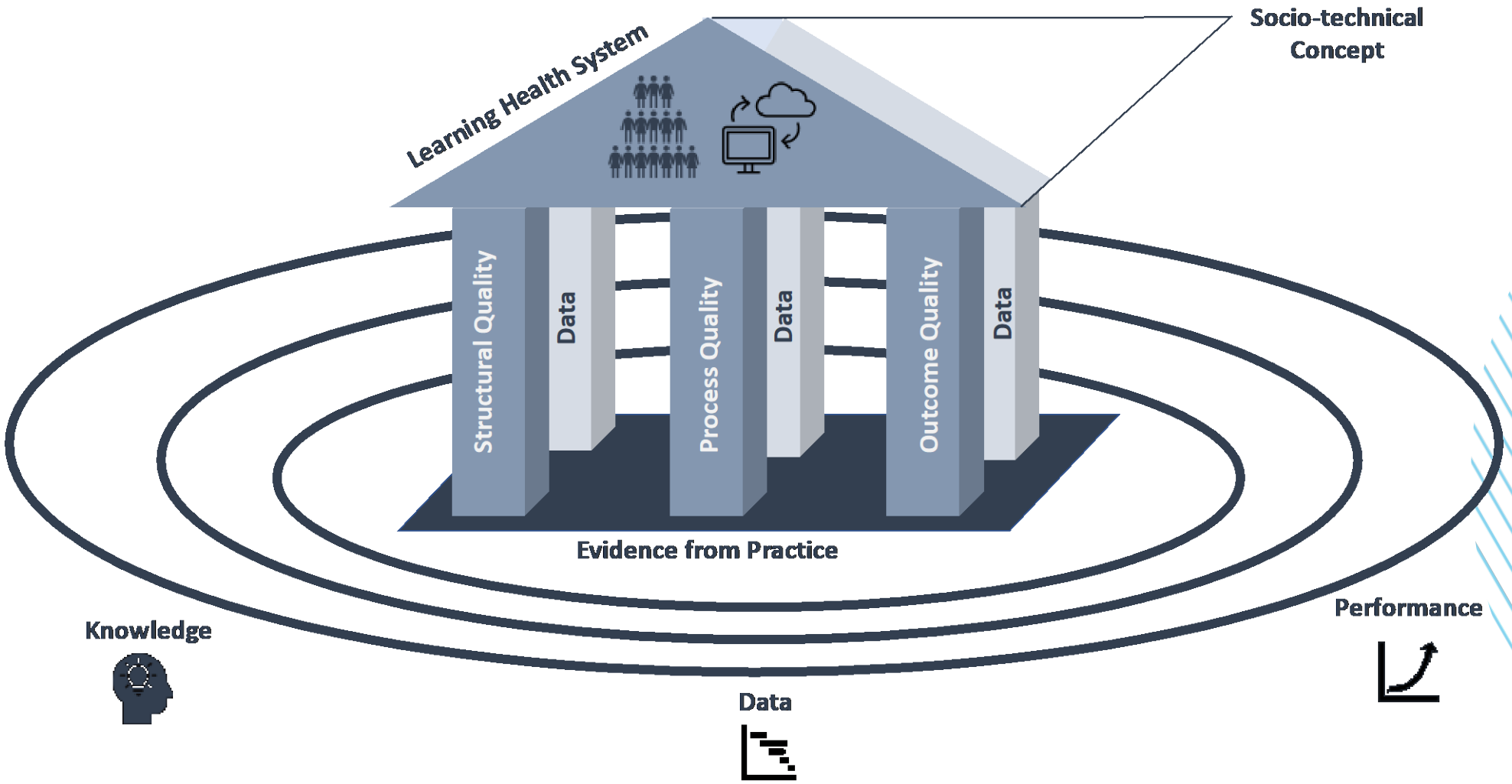
The Learning Health System

Ursula H. Hübner

Professor of Medical and Health Informatics and Quantitative Methods

With the support of the Erasmus+ Programme of the European Union

What is a Learning Health System?



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The LHS Learning Cycle

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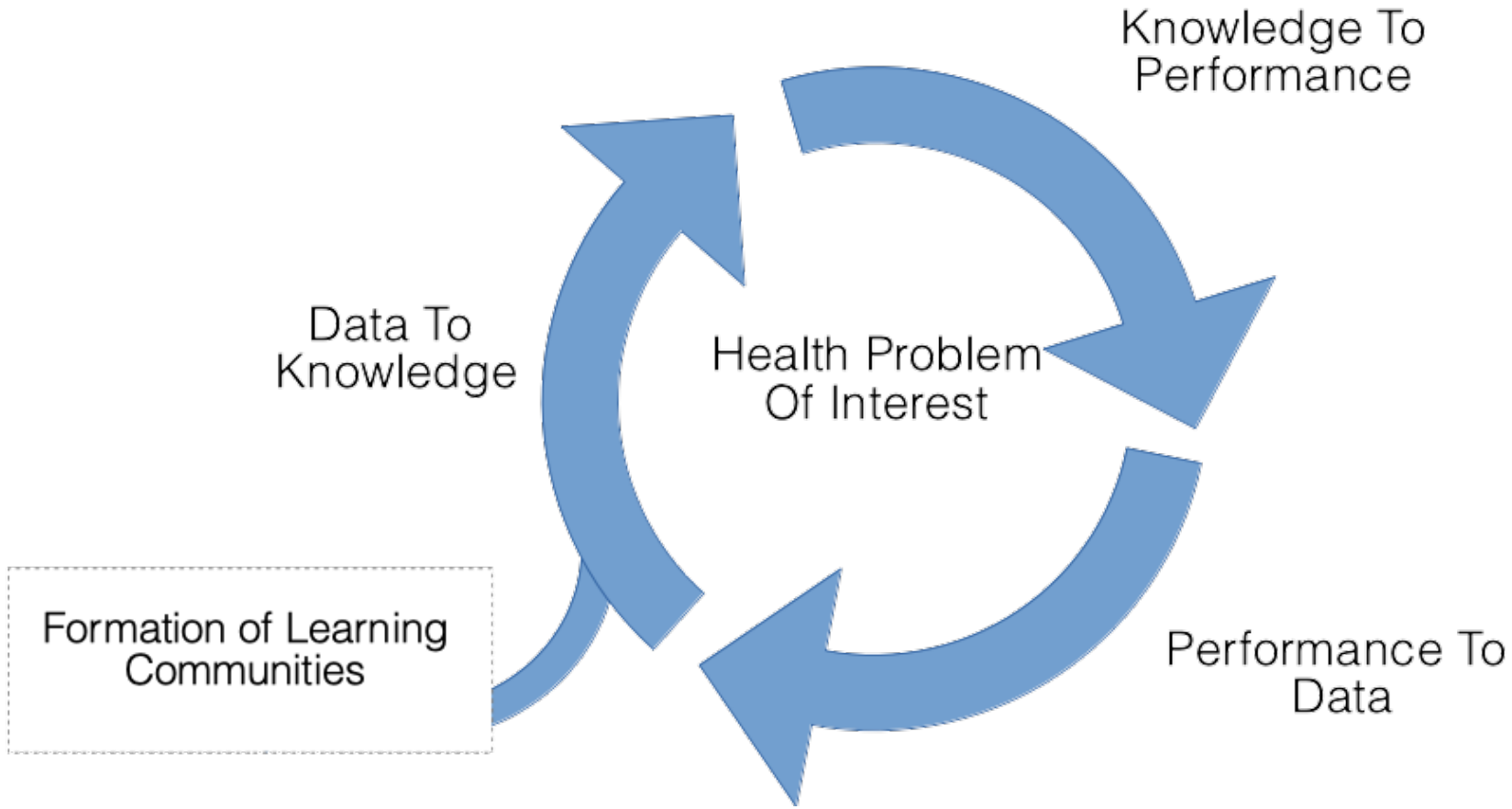

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The LHS Learning Cycle

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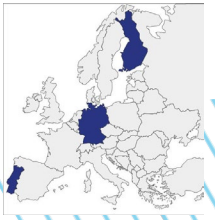
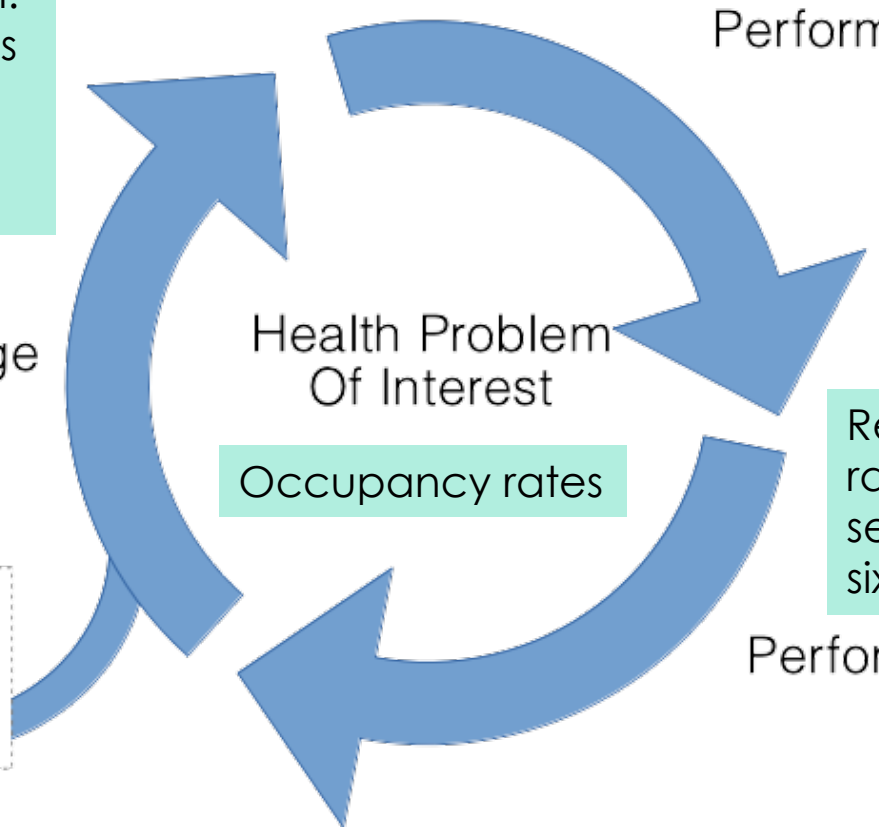


Knowing that 20% of the out patients in cardiology do not show up on Mondays and Fridays.
These days can be overbooked.

Data in patient booking system: Longitudinal analysis of patients who did not show up. Development of a forecasting model.



Formation of Learning Communities

Recording the occupancy rate in cardiology over the seven days of the week for six months.

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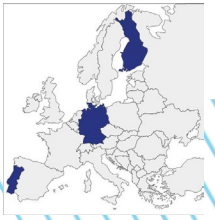
Types of an LHS



Types	Examples
Automation	Pre-populated forms for ordering lab tests
Benchmarks	Comparison with the best in emergency department throughput
Predictions and Forecasts	Consumption of medical products such as wound dressings, prescription of antibiotics
Decision support	Decision support in differential diagnosis of a chronic wound
Real-time Surveillance	Infection rates of newborns
Research Support	Identification of patient cohorts for heart failure and patients older than 65 years for quasi-experimental study design

Foley TJ, Vale L. What role for learning health systems in quality improvement within healthcare providers? Learn Health Syst. 2017 May 31;1(4):e10025. doi: 10.1002/lrh2.10025.

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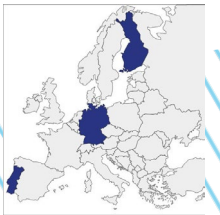
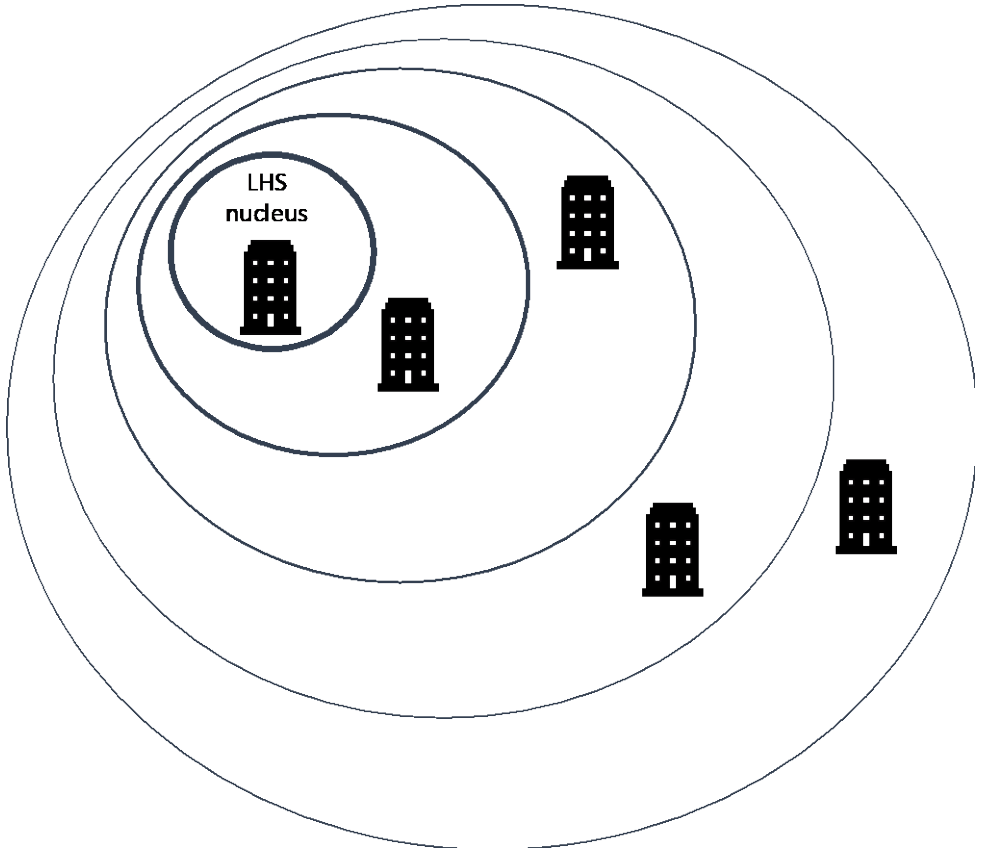
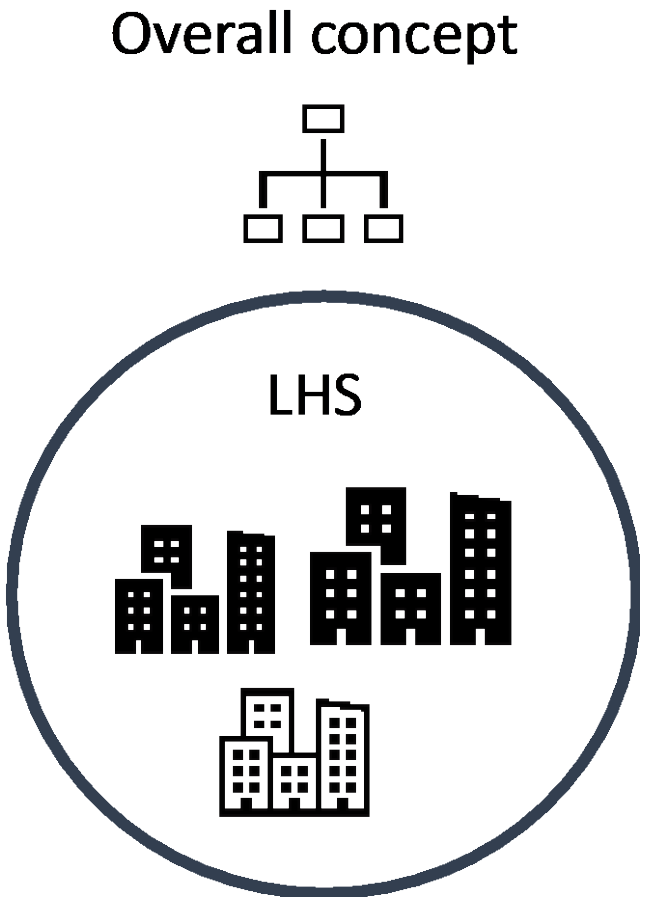
Local vs. national Learning Health Systems



Local LHS with the potential to grow



National LHS with a predefined concept



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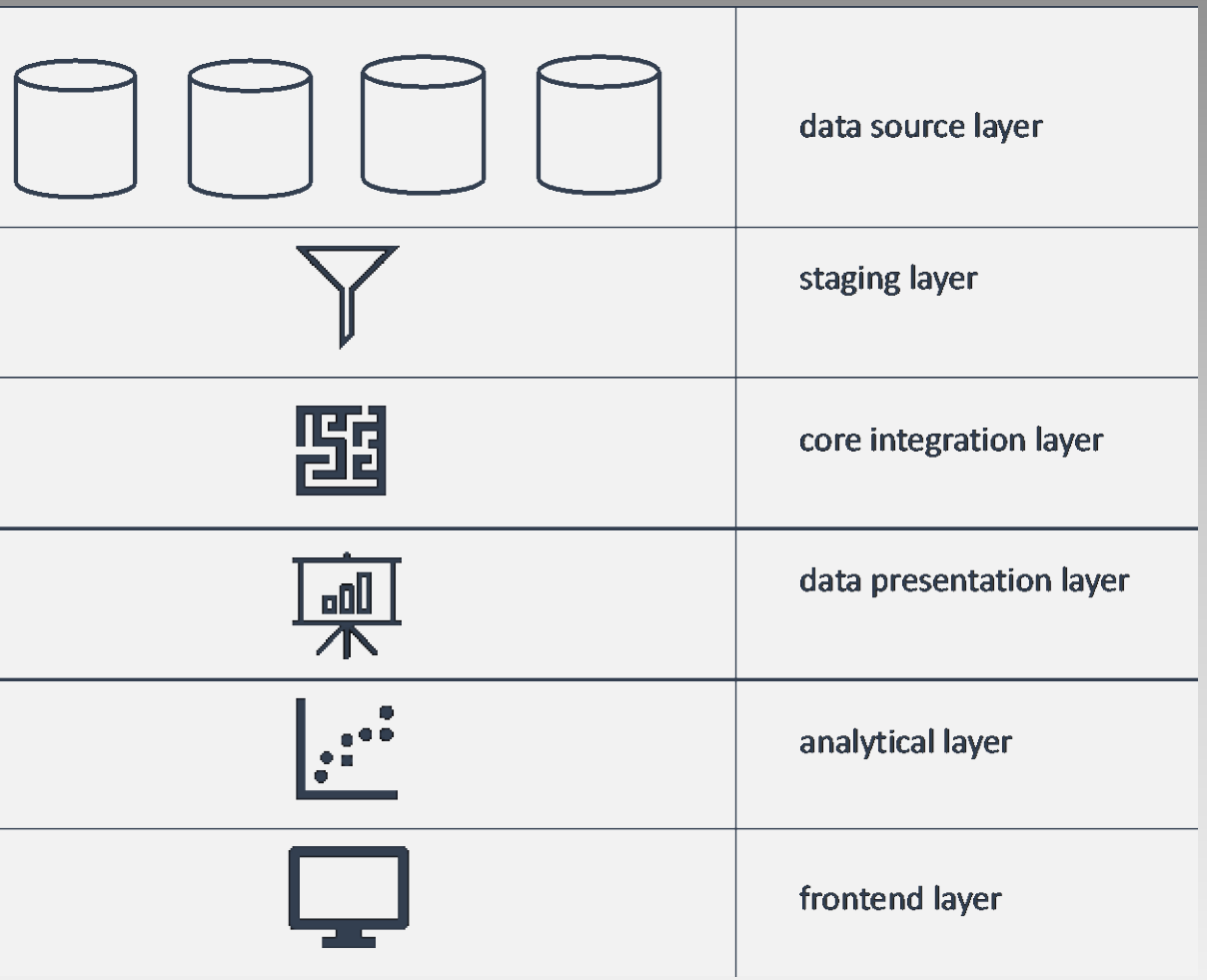
Rauch J, Hübner U. Learning Health Systems: Concepts, Principles and Practice for Data-Driven Health. In: Hübner U, Wilson M. G., Shaw Morawski T, Ball MJ Nursing Informatics: A Health Informatics, Interprofessional and Global Perspective. Springer London 2021

Technical Architecture of an LHS

With the support of the Erasmus+ Programme of the European Union

Lawful and safe use of data



Interoperable electronic health records

Extraction, Transform, Load
ETL pipeline

Data warehouse

Data visualisation

Data analytics

Dashboard

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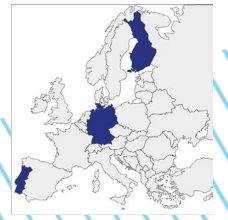
Learning Health Systems: Example



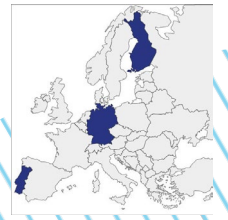
Example 1

The Veterans Health Administration belongs to the US Department of Veterans Affairs (VA)), and is the largest integrated health care system in the country, which provides care at 1,255 health care facilities, including 170 medical centers and 1,074 outpatient sites of care [23]. It operates an extensive network of EHRs. A clinical data warehouse integrates patient data from local EHRs to make them available for application in a nationwide LHS. To improve the quality of care for veterans with a transient ischemic attack (TIA) and thus reduce the stroke risk, the VA started the PREVENT program as an LHS application [24]. The primary outcome is the provision of all types of care TIA patients are eligible for, e.g. anticoagulation therapy, brain imaging and carotid imaging, statin therapy. A dashboard serves as a hub for the LHS that integrates and visualizes data on the performance of a hospital site which allows benchmarking. The dashboard serves as a source of clinical guidelines and other educational and scientific material. It is intended to be used as a meeting place for teams from different locations in the VA and professions. When evaluating this system, the users appreciated the access to data and their integration as well as the opportunity to monitor the progress in their own department. They found that it motivated teams to drill down to individual cases when overall rates got worse or did not meet the expectations. This contributed to active team learning and establishing a community of practice across the organization involving providers from different departments and reaching a multidisciplinary approach to achieve quality improvements. The hub turned out to be a catalyst for learning how to learn [24].

Rattray NA, Damush TM, Miech EJ, Homoya B, Myers LJ, Penney LS, Ferguson J, Giacherio B, Kumar M, Bravata DM. Empowering Implementation Teams with a Learning Health System Approach: Leveraging Data to Improve Quality of Care for Transient Ischemic Attack. J Gen Intern Med. 2020 Nov;35(Suppl 2):823-831. doi: 10.1007/s11606-020-06160-y.

Learning Health Systems: Data Analytics

With the support of the Erasmus+ Programme of the European Union



Analytical Method	Purpose	Examples
Descriptive statistics	Describe sample, obtain overview	Age distribution of patients in emergency department
Classical inferential statistics	Hypotheses testing	Do young physicians prescribe antibiotics more often than older physicians?
Data mining	Data exploration for new patterns, outliers (anomaly) detection, dependencies (associations, sequences)	Patient phenotyping, e.g. defining homogenous subgroups in obese patients
Time series analysis	Analysis of longitudinal data: detection of patterns and change, forecasting	Survival analysis of patients with full functional recovery from stroke, ARIMA time series models for forecasting the occupancy of ICU beds for COVID-19 patients
Machine Learning	Supervised learning, clustering, reduction of dimensions, structured prediction, anomaly detection, neural networks, reinforcement learning	Classification of chronic wounds from wound images, prediction of therapy outcomes

Rauch J, Hübner U. Learning Health Systems: Concepts, Principles and Practice for Data-Driven Health. In: Hübner U, Wilson M. G., Shaw Morawski T, Ball MJ Nursing Informatics: A Health Informatics, Interprofessional and Global Perspective. Springer Nature 2022

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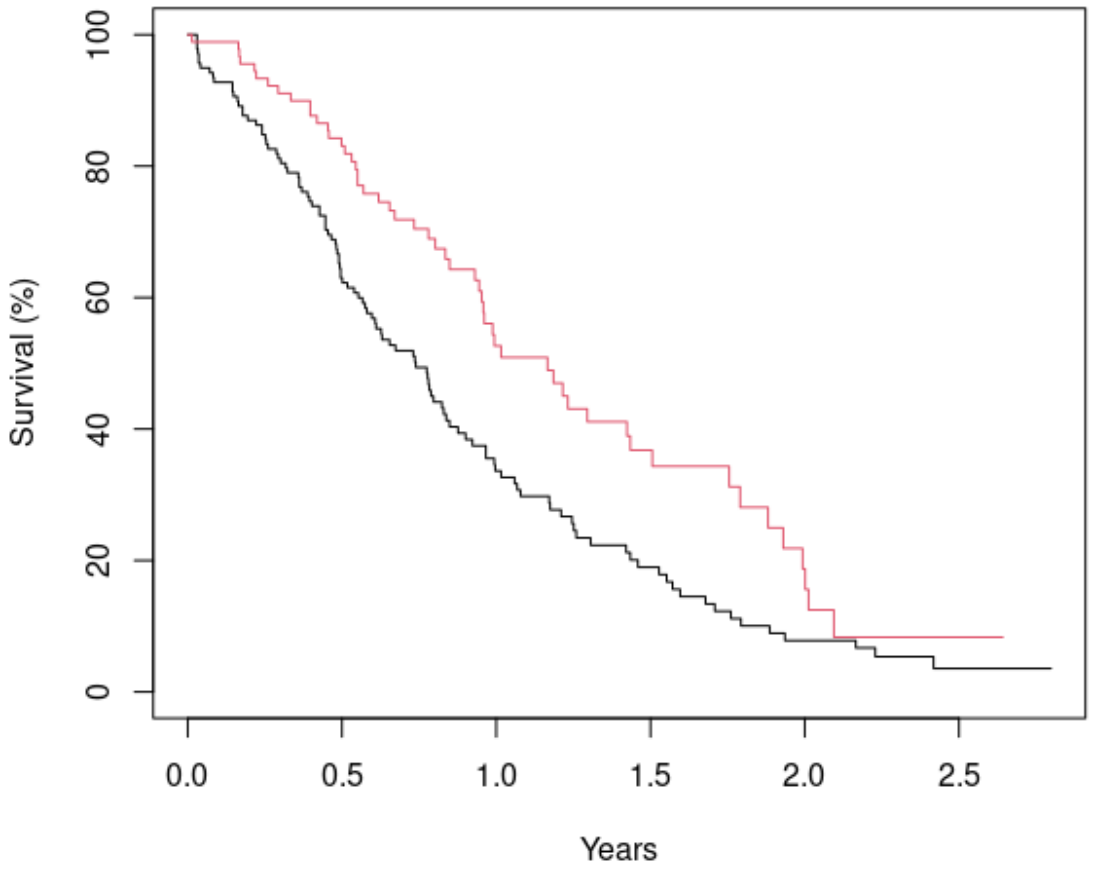
Survival Analysis of Lung Cancer Patients



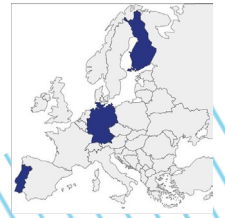
Survival data for lung cancer patients (females in red, males in black) shown as a Kaplan-Meyer curve. When the proportional hazards assumption holds, the curves for a factor are approximately parallel.

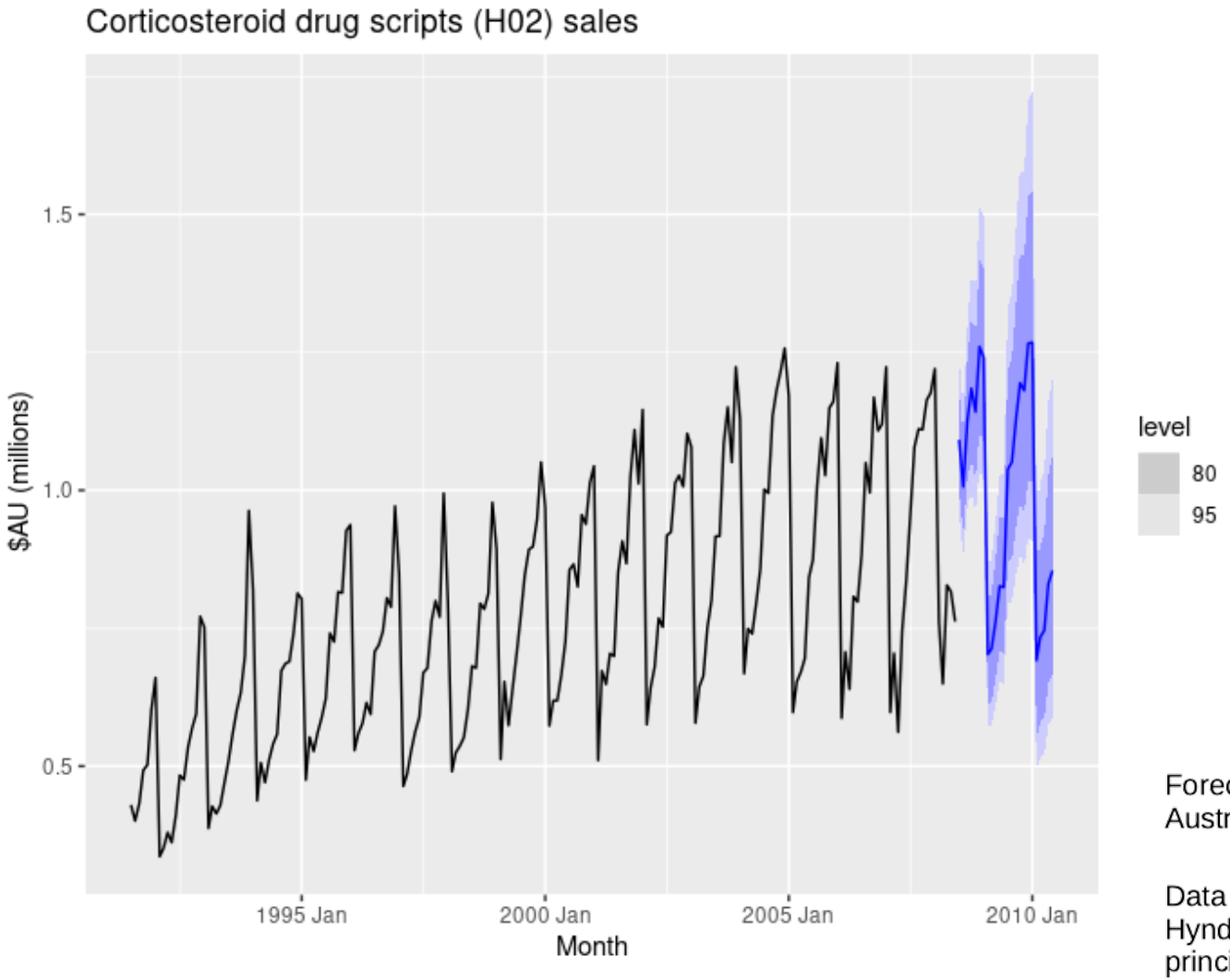
Data from:
Therneau, Terry M., and Thomas Lumley. "Package 'survival'." R Top Doc 128.10 (2015): 28-33.

Loprinzi CL. Laurie JA. Wieand HS. Krook JE. Novotny PJ. Kugler JW. Bartel J. Law M. Bateman M. Klatt NE. et al. Prospective evaluation of prognostic variables from patient-completed questionnaires. North Central Cancer Treatment Group. Journal of Clinical Oncology. 12(3):601-7, 1994.

With the support of the Erasmus+ Programme of the European Union

Time Series Analysis: Forecast Drug Prescription





Forecasts from an ARIMA model applied to monthly Australian corticosteroid (H02) prescription data.

Data from:
Hyndman, Rob J., and George Athanasopoulos. Forecasting: principles and practice. OTexts, 2018.

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Example: Frail patients in EDs

Setting: Emergency Department Klinikum Osnabrück Germany (Jan 2017 – Jul 2018)

	Non-frail	Frail	Total
Within GP hours	20,693	3,152	23,845
Outside GP hours	21,399	2,837	24,272
Total	42,092	6,025	48,117

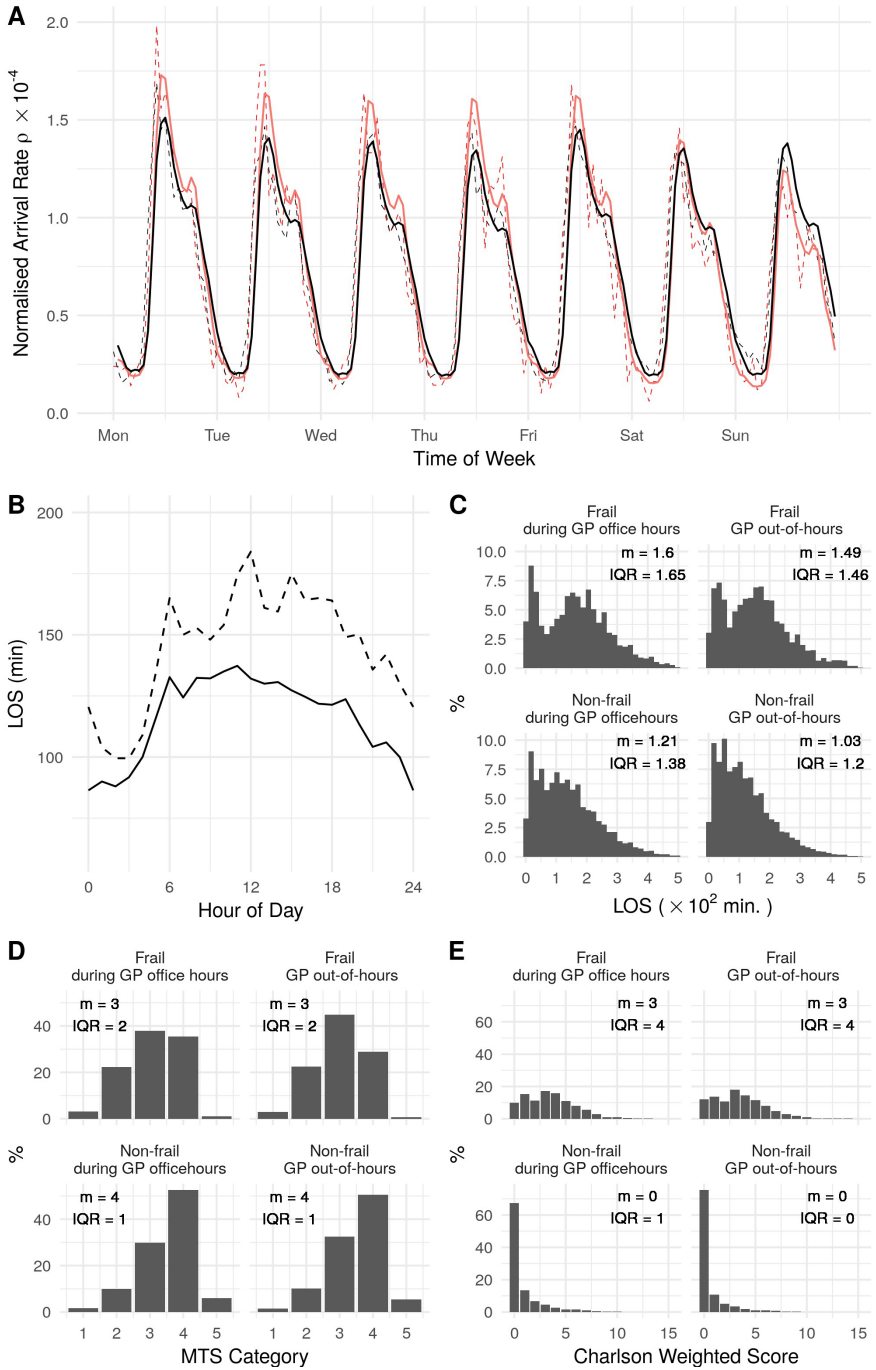
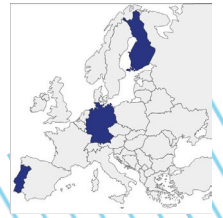


Figure 1. Comparison of frail vs. non-frail patients by time of day. (A) Modelled (solid lines) and observed (dashed lines) normalised mean arrival rates to the ED (black: non-frail patients). (B) Median length of stay in the ED dependent on time of arrival (dashed line: frail patients). (C-E) Relative frequencies and medians (*m*) and interquartile range (IQR) for LOS, triage (Manchester Triage System) and Charlson comorbidity score.

Rauch J, Denter M, Hübner U. Use of Emergency Departments by Frail Elderly Patients: Temporal Patterns and Case Complexity. Stud Health Technol Inform. 2019 Sep 3;267:215-223. doi: 10.3233/SHTI190830.

With the support of the Erasmus+ Programme of the European Union



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Clinical Data Analytics: From Data to Knowledge

This course is a part of the eHealth4all@EU research project.

It was co-developed with the research initiative Zukuftslabor Gesundheit Niedersachen (Furture Labs in Lower Saxony, funded by the MWK)

For further information, please visit: https://www.hs-osnabrueck.de/ehealth4alleu/

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eHealth4All@EU – 2022 Porto Summer School

We are here

SCHEDULE

DAY 1 | THURSDAY | 8 SEP 2022

Time	Activity description
16:00-18:00	Registration

Where?
Coffee Breaks:
- YOU restaurante (weekdays);
- FMUP Entrance Hall (weekends).

Lectures: L5 classroom

Wi-fi
Use the browser to enter credentials
Network: Uporto
User: eH4A
Password: eH4A2022

DAY 2 | FRIDAY | 9 SEP 2022

Time	Activity description
09:00-09:30	Late registration
09:30-10:30	Introduction to Summer School and General Information
10:30-10:50	Coffee Break
10:50-13:00	Interoperability
13:00-14:00	Lunch break
14:00-16:00	Interoperability
16:00-16:20	Coffee Break
16:30-19:30	City Tour and visit
20:00	Dinner

DAY 3 | SATURDAY | 10 SEP 2022

Time	Activity description
09:30-10:30	Interoperability
10:30-10:50	Coffee Break
10:50-13:00	Interoperability
13:00-14:00	Lunch break
14:00-16:00	Interoperability
16:00-16:20	Coffee Break
16:20-17:30	Interoperability

DAY 4 | SUNDAY | 11 SEP 2022

Time	Activity description
09:30-10:30	Data Protection & Security
10:30-10:50	Coffee Break
10:50-13:00	Data Protection & Security
13:00-14:00	Lunch break
14:00-16:00	Data Protection & Security
16:00-16:20	Coffee Break
16:20-17:30	Data Protection & Security

DAY 5 | MONDAY | 12 SEP 2022

Time	Activity description
09:30-10:30	Data Protection & Security
10:30-10:50	Coffee Break
10:50-13:00	Data Protection & Security
13:00-14:00	Lunch break
14:00-16:00	Data Analytics
16:00-16:20	Coffee Break
16:20-17:30	Data Analytics

DAY 6 | TUESDAY | 13 SEP 2022

Time	Activity description
09:30-10:30	Data Analytics
10:30-10:50	Coffee Break
10:50-13:00	Data Analytics
13:00-14:00	Lunch break
14:00-16:00	Data Analytics
16:00-16:20	Coffee Break
16:30-17:30	Feedback and Evaluation
17:30	Closing Social Event

DAY 5| MONDAY | 12 SEP 2022	
Time	**Activity Description**
14:00 - 16:00	1. Lecture: Learning Health Systems (Ursula)
	2. Introduction: Data Analytics (Jens)
16:00 - 16:20	Coffee Break
16:20 - 17:30	Hands on Data and Data Exploration
DAY 6| MONDAY | 12 SEP 2022	
Time	**Activity Description**
9:30 - 10:30	Recap and Group Work
10:30 - 10:50	Coffee Break
10:50 - 13:00	Group Work
13:00 - 14:00	Lunch Break
14:00 - 15:00 (one hour shorter)	Presentations, Questions and Discussion

What are the three leading causes of death in health care?

What are the three leading causes of death in health care?

thebmj

BMJ 2016;353:i2139 doi: 10.1136/bmj.i2139 (Published 3 May 2016)

ANALYSIS

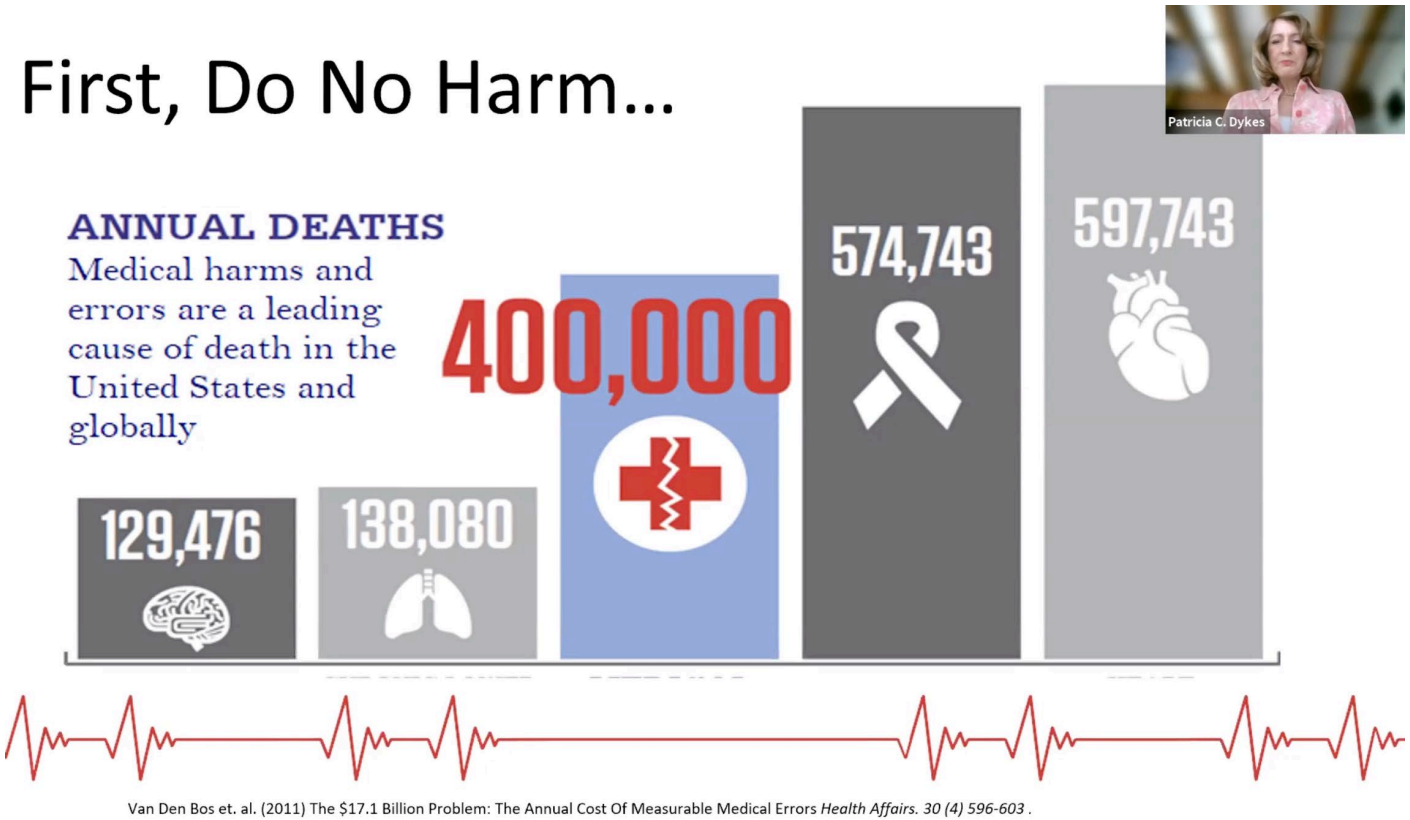
Medical error—the third leading cause of death in the US

Medical error is not included on death certificates or in rankings of cause of death. **Martin Makary** and **Michael Daniel** assess its contribution to mortality and call for better reporting

Martin A Makary *professor*, Michael Daniel *research fellow*

Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD 21287, USA

What are the three leading causes of death in health care?



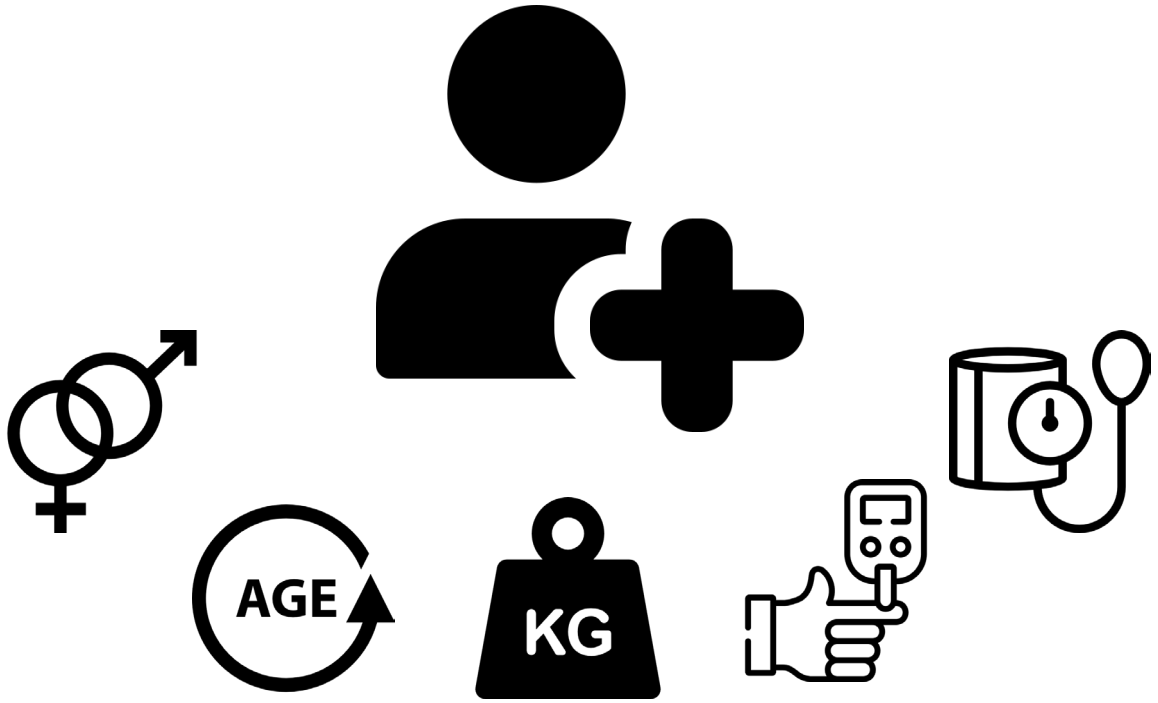
"We believe that the **application of data science and medical informatics methods** have tremendous potential […] **improve health care safety** by providing solutions to **predict harm**, including **data-driven clinical decision support** that can **identify patients at risk for harm** and also provide early intervention strategies"

Patricia Dykes from Harvard on the MIE2021

So, why are we taking about health data and data analytics?

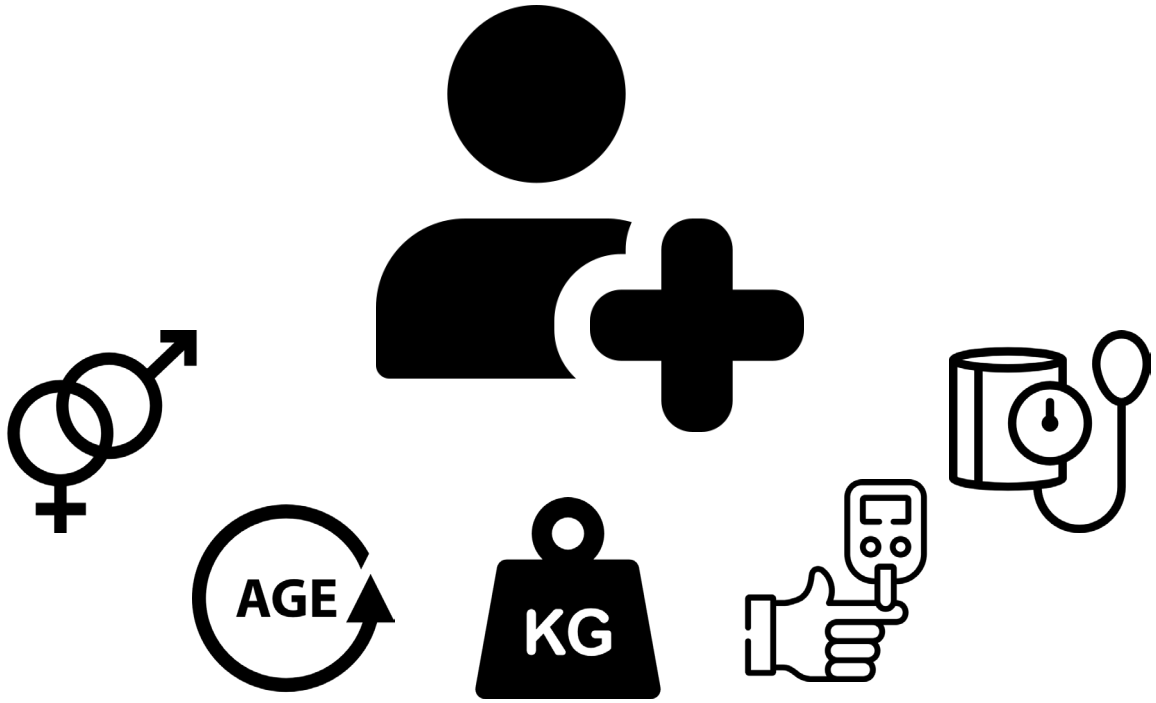
From Data to Knowledge

Interoperable Data



- Standards enable interoperable Data
  - The data structure is system independent
  - Health information is able to flow between applications and organizations
  - Data pooling is possible (e.g. in a data warehouse)

From Data to Knowledge

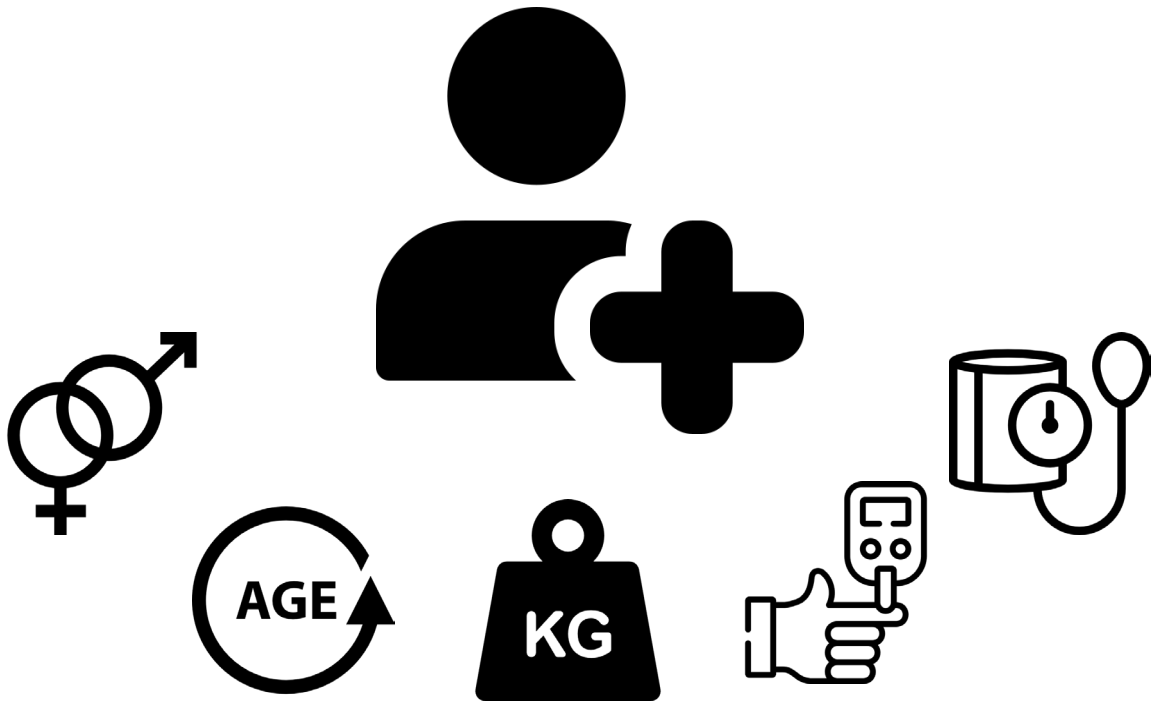


openEHR

Two widespread data standards in health care

HL7® FHIR®

From Data to Knowledge



HL7 FHIR

openEHR

Tabular Data

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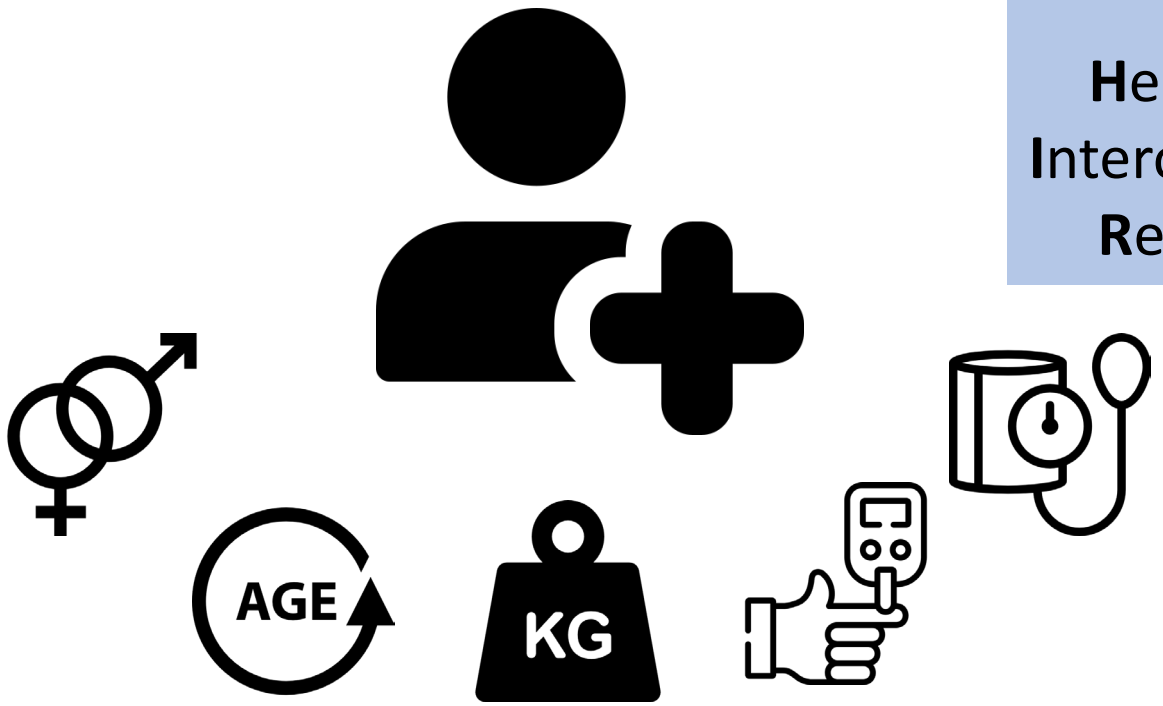
From Data to Knowledge

HL7® FHIR®

- Interoperable Data with FHIR – The Data Pipeline

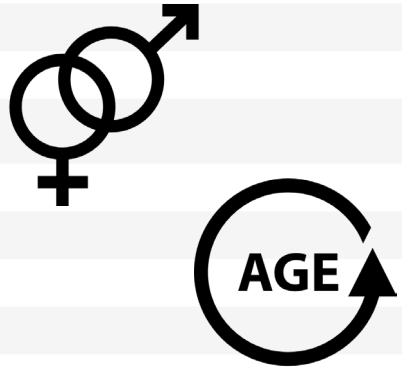


Fast
Healthcare
Interoperability
Resources

From Data to Knowledge

- Patient Ressource

Name	Flags	Card.	Type	Description & Constraints
Patient	N		DomainResource	Information about an individual or animal receiving health care services Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	An identifier for this patient
active	?! Σ	0..1	boolean	Whether this patient's record is in active use
name	Σ	0..*	HumanName	A name associated with the patient
telecom	Σ	0..*	ContactPoint	A contact detail for the individual
gender	Σ	0..1	code	male | female | other | unknown AdministrativeGender (Required)
birthDate	Σ	0..1	date	The date of birth for the individual
deceased[x]	?! Σ	0..1		Indicates if the individual is deceased or not
deceasedBoolean			boolean	
deceasedDateTime			dateTime	
address	Σ	0..*	Address	An address for the individual
maritalStatus		0..1	CodeableConcept	Marital (civil) status of a patient MaritalStatus (Extensible)

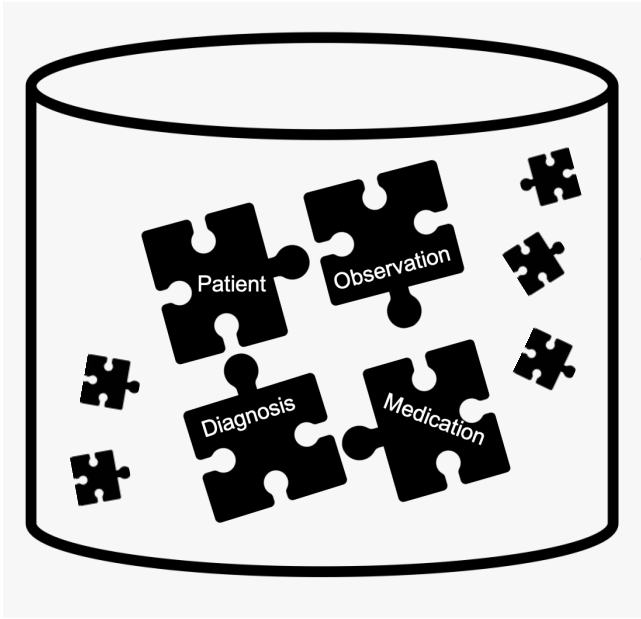


Subset of the Patient Resource

https://www.hl7.org/fhir/patient.html

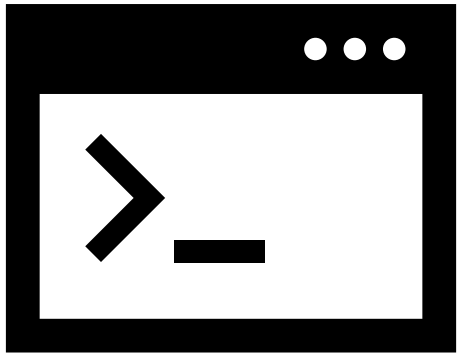
From Source data to tabular data

- Extract – Transform - Load



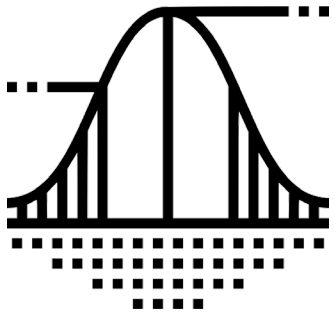
Hospital Information System

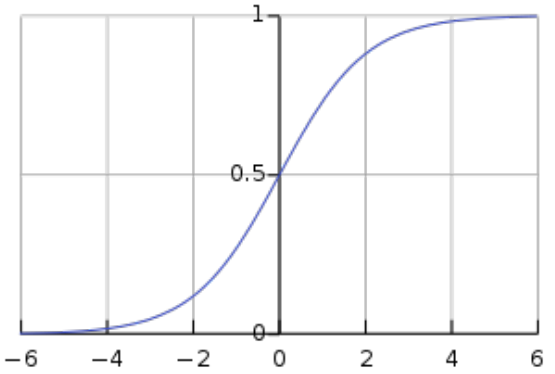
ETL Process



Tabular Data

Patient_ID	Age	Diabetes	Smoking	SystolicBP	Inactivity	BMI
1231231	33	0	1	124	0	22
4354672	39	0	1	134	1	28
2344221	56	1	0	120	1	30
4545577	60	1	0	119	0	20
2341134	55	1	1	133	0	29

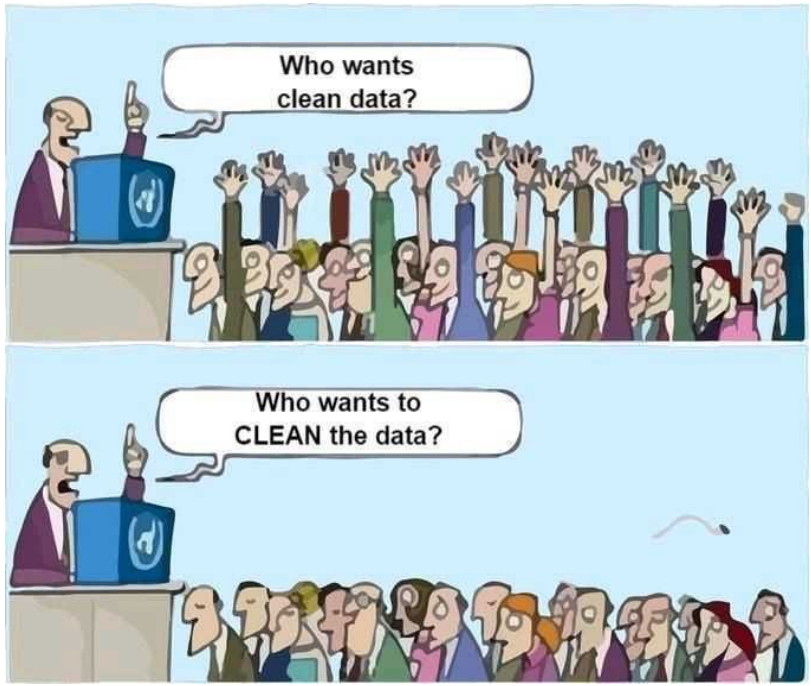




Statistical Models

From Source data to tablular DATA

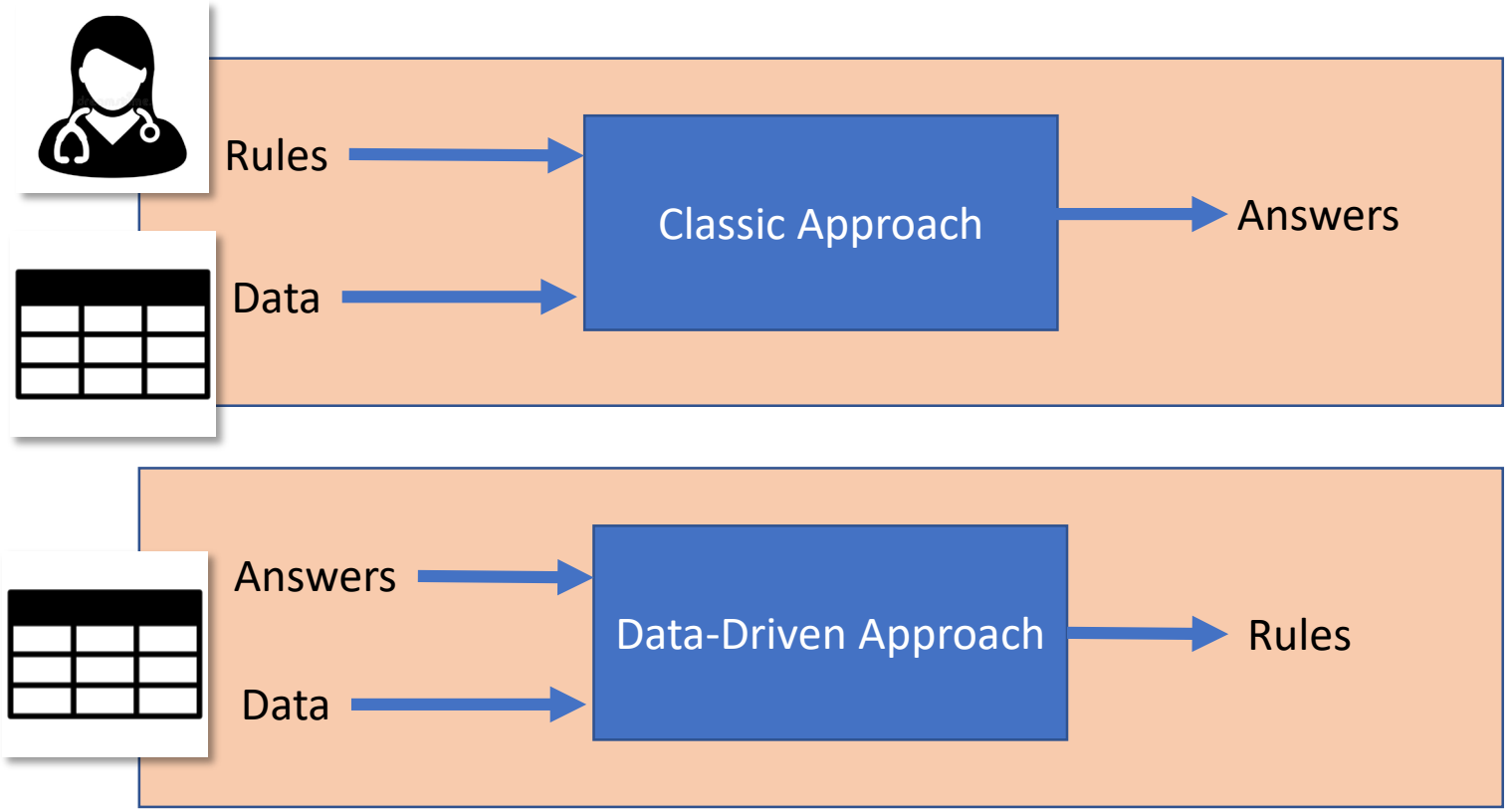
- Extract – Transform - Load



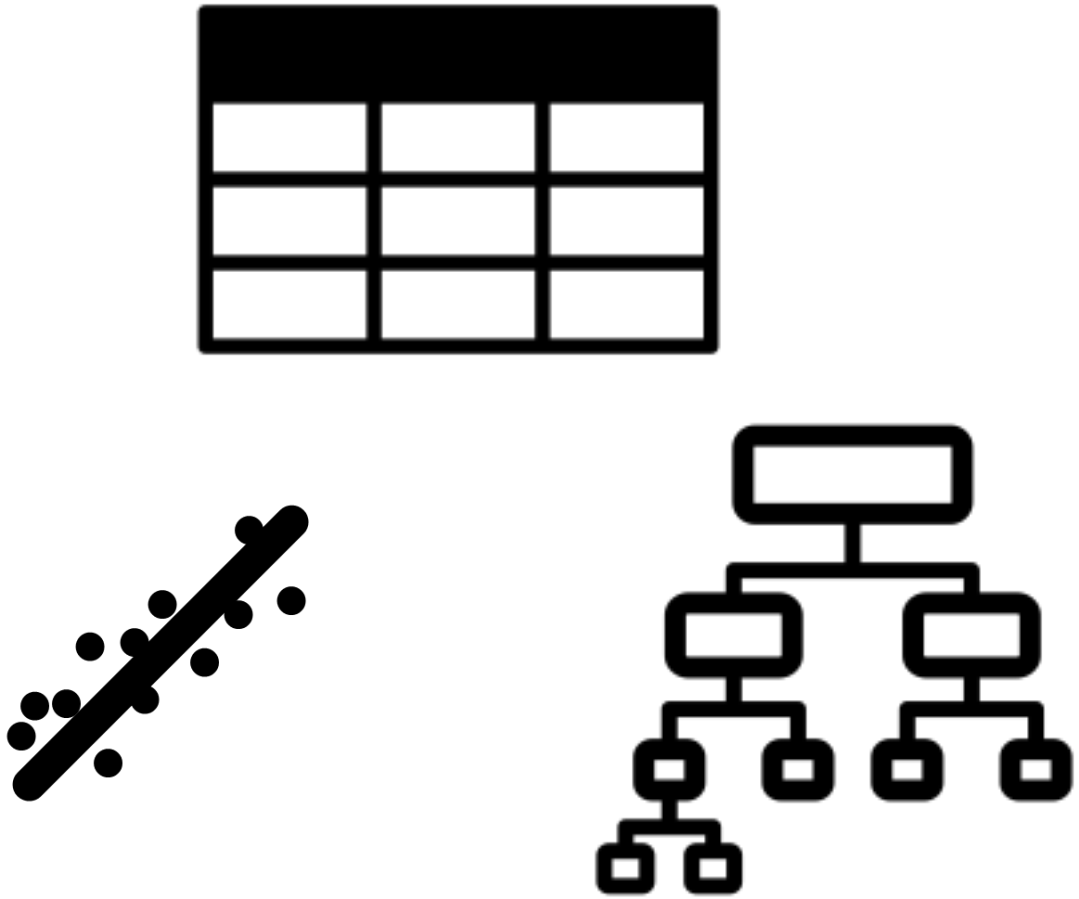
Clinical Decision Support Systems

- **Computers** could **assist** with **difficult decisions** in complex clinical situations is an **old idea**!
- The first academic article on this subject appeared in the scientific literature about 60 years ago (Ledley et Lusted 1958)
- Today, they such systems are called Clinical Decision Support Systems
- The **evolution** of **digital** and **communication technologies** in recent years has resulted in impressive new capabilities.

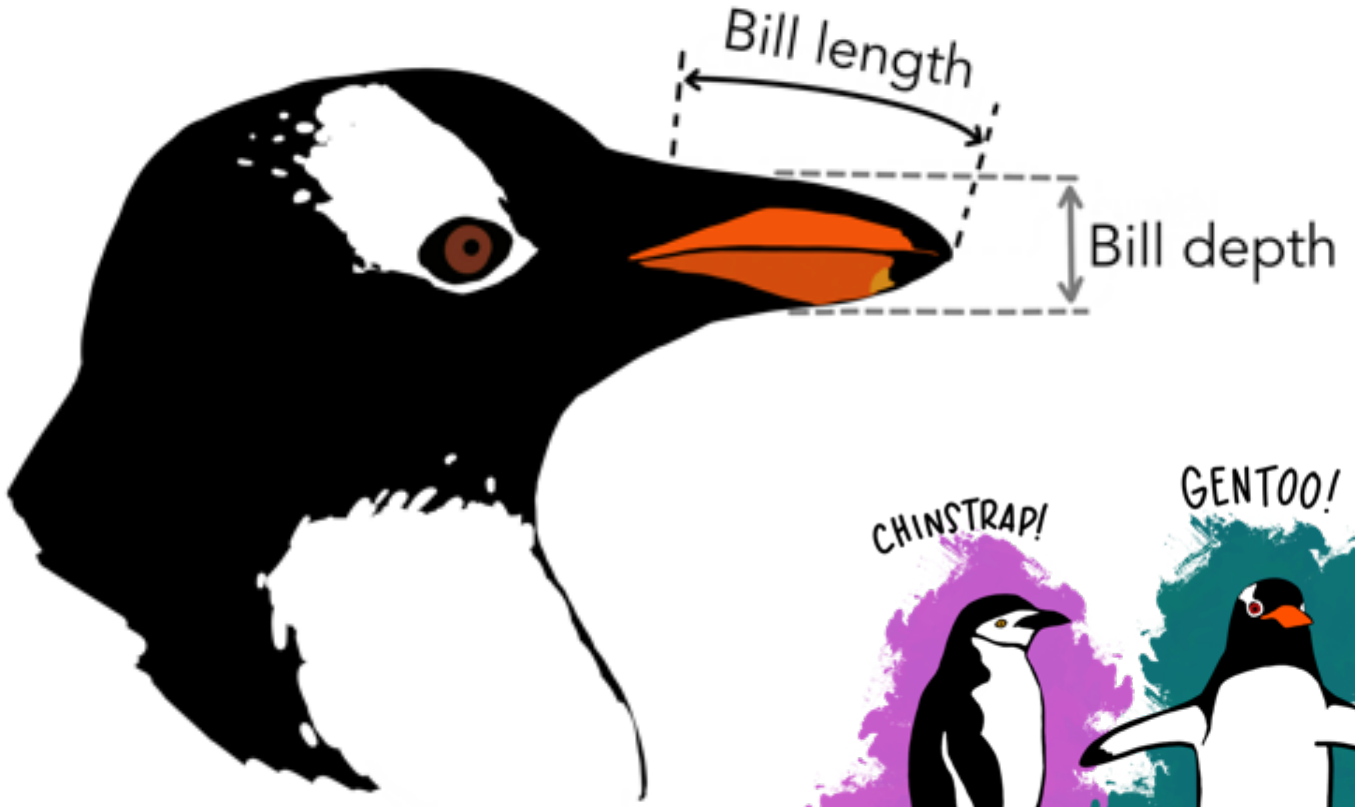
Clinical Decision Support Systems

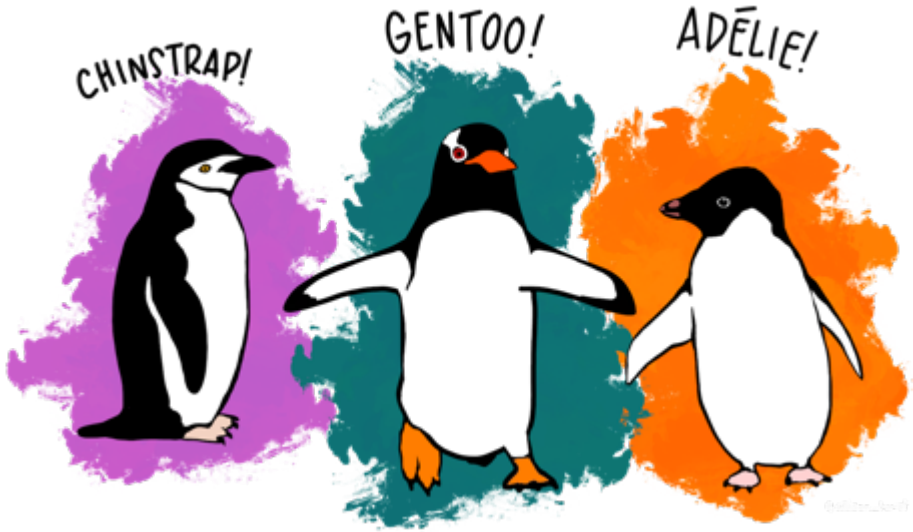


Data Driven Learning



Data Driven Learning

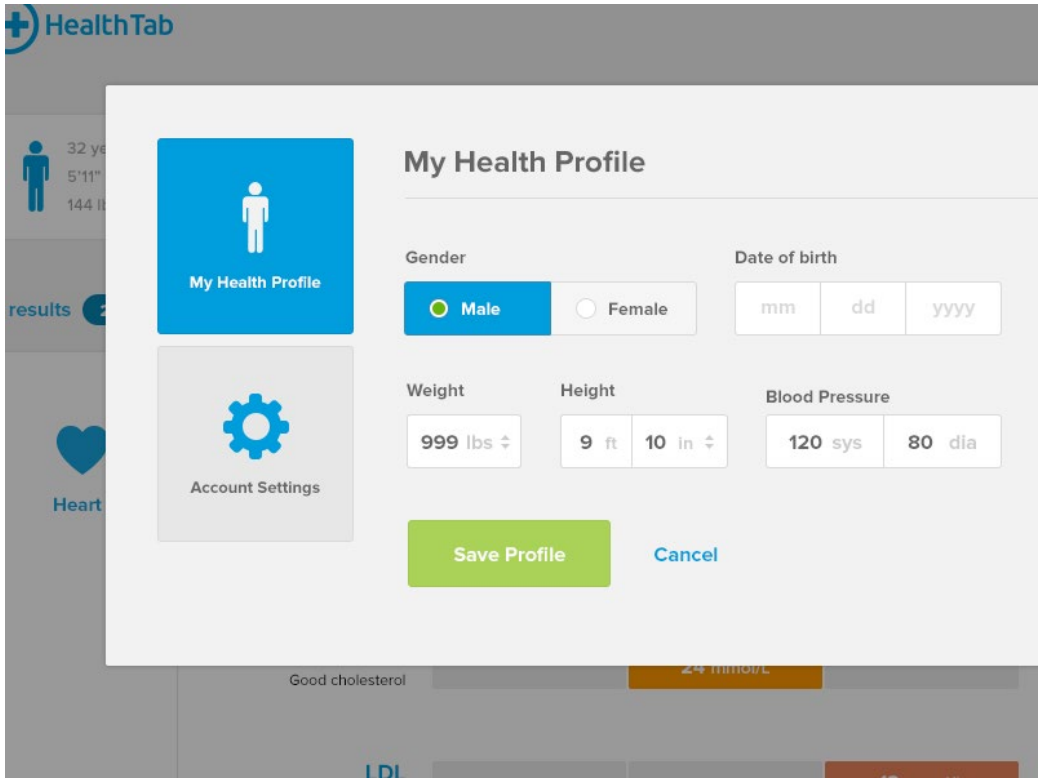




Data Driven Learning

Decision Support In Health Care

Electronic Health Record (EHR)



What is the patients risk of CHD?

- The EHR contains information on demographic and clinical data.
- At a university hospital, clinicians and statisticians have developed a clinical decision support system to estimate patients' CHD risk
- The estimate is based on clinical data
- As the outcome is binary and the clinicians want the individual risk (probability) they used logistic regression

Clinical Decision Support Systems

- https://jnshsrs.shinyapps.io/pedis-prediction

Data Analytics

Applied

Relationship between Sunshine and Ice Cream Consumption

- Does the information about the weather tell us something about ice cream consumption?

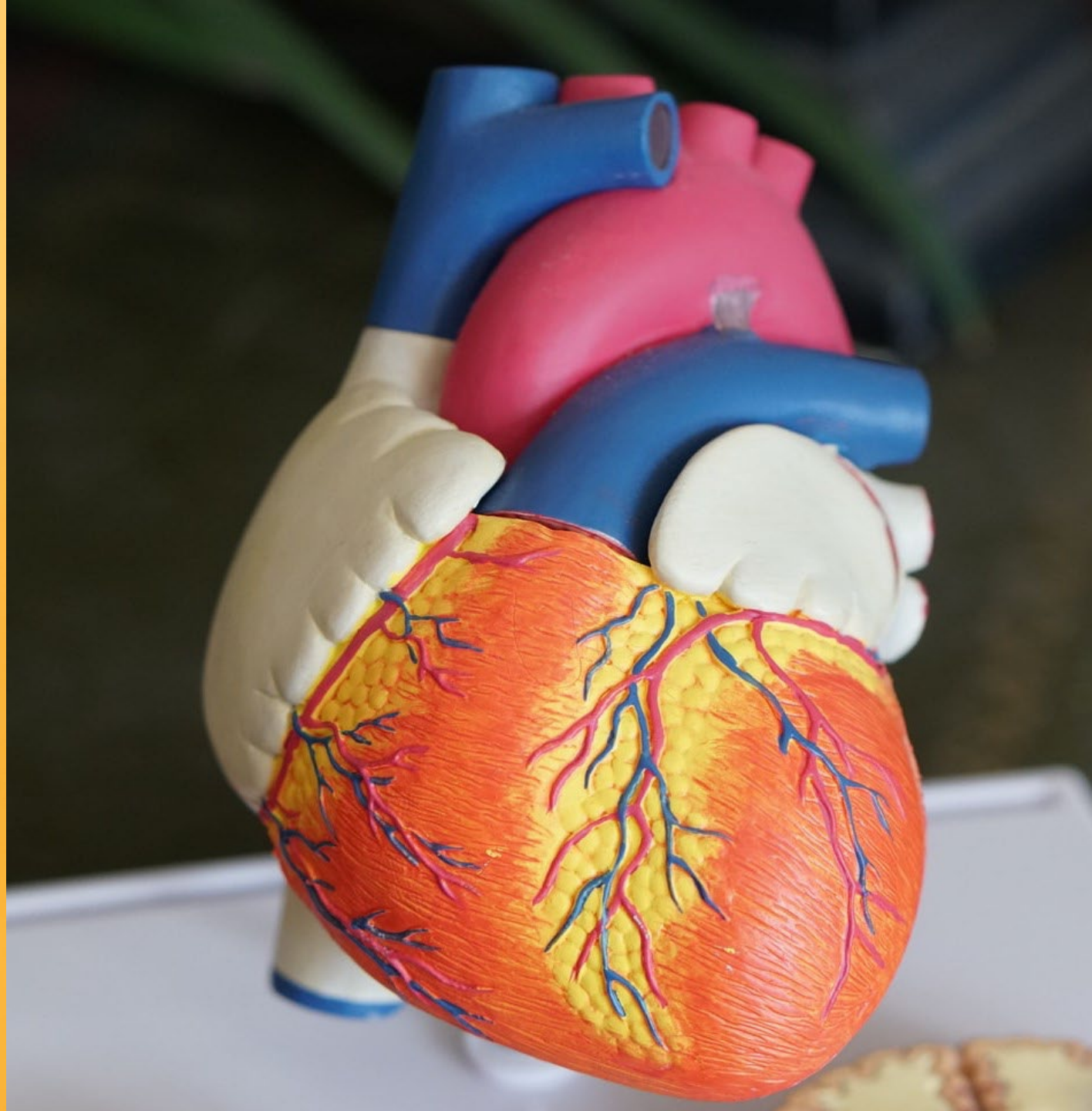
- If yes, then, both variables are related.

- Let‘s ask randomly as many people as possible if they have had ice cream
  - On a sunny day
  - And on a non-sunny day

Relationship between Sunshine and Ice Cream Consumption

		Outcome		
		Outcome Positive	Outcome Negative	
Exposure/ Risk Factor/ Predictor	Exposure Present	A	B	A+B
	Exposure Absent	C	D	C+D
		A+C	B+D	A+B+C+D

Lecturer:
Jens Hu[illegible]



Example of risk factors of premature CHD

		Outcome		
		Coronary Heart Disease present	Coronary Heart Disease absent	
Exposure/ Risk Factor/ Predictor	CVD in Family History	502	50102	50604
	No CVD in Family History	532	180231	180763
		1034	230333	231367

$$Risk_{CVD} = \frac{502}{502 + 50102} = 0{,}01 = 1\%$$

$$Risk_{No\ CVD} = \frac{532}{532 + 180231} = 0{,}0029 \approx 0.3\%$$

$$Relative\ Risk = \frac{Risk_{CVD\ FamHist}}{Risk_{No\ CVD\ FamHist}} = 3{,}37$$

The **risk** (probability) of CHD is 3.37 times higher with exposed (CHD of family members) subjects than non-exposed subjects.
Family history is associated with premature CHD, as the risk has more than tripled.
A family history of cardiovascular disease is a risk factor for premature CHD.

Example of risk factors of premature CHD

		Outcome: Coronary Heart Disease present	Outcome: Coronary Heart Disease absent	
Exposure/ Risk Factor/ Predictor	CVD in Family History	502	50102	50604
	No CVD in Family History	532	180231	180763
		1034	230333	231367

$$Risk_{CVD} = \frac{502}{502 + 50102} = 0{,}0099$$

$$Odds_{CVD} = \frac{502}{50102} = 0{,}01002$$

$$Risk_{No\ CVD} = \frac{532}{532 + 180231} = 0{,}0029$$

$$Odds_{No\ CVD} = \frac{532}{180231} = 0{,}00295$$

$$Relative\ Risk = \frac{Risk_{CVD\ FamHist}}{Risk_{No\ CVD\ FamHist}} = 3{,}37$$

$$Odds\ Ratio = \frac{Odds_{CVD\ FamHist}}{Odds_{No\ CVD\ FamHist}} = \frac{0{,}01002}{0{,}00295} = 3{,}39$$

Odds Ratios for binary Risk-Factors

- To quantify the relationship between two binary measures (variable)
  - Family history of cardiovascular cases absent or present
  - Condition of coronary heart disease absent or present

		Coronary Heart Disease present	Coronary Heart Disease absent	
Exposure/ Risk Factor/ Predictor	CHD in Family History	24	8	32
	No CHD in Family History	76	92	168
		100	100	200

Odds Ratio: 3.63

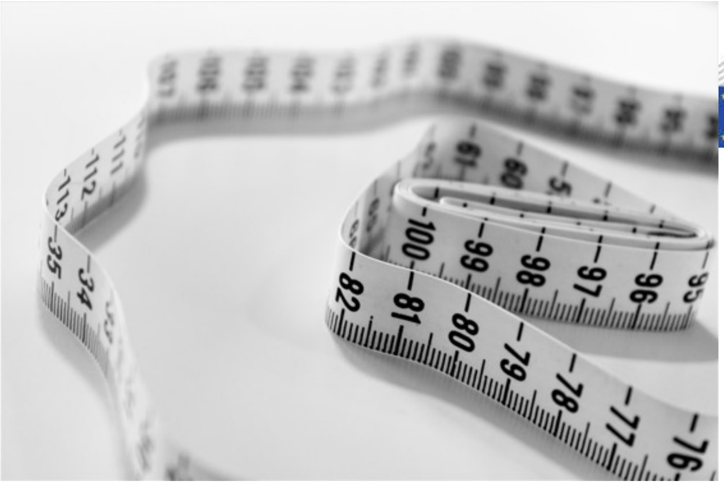
Continuous Variables

- Body Weight in KG
  - Far too many “categories” (e.g. 80.1kg, 80.2kg)
  - Values on a continuous spectrum

Can you name some binary and continuous variables? (that are important in health care)

Continuous Variables

- Body Weight in KG
  - Far too many "categories" (e.g. 80.1kg, 80.2kg)
  - Values on a continuous spectrum
- Body Height in m, cm, mm, …
- Blood Pressure in mmHg
- LDL Cholesterol Levels in the blood mg/dL

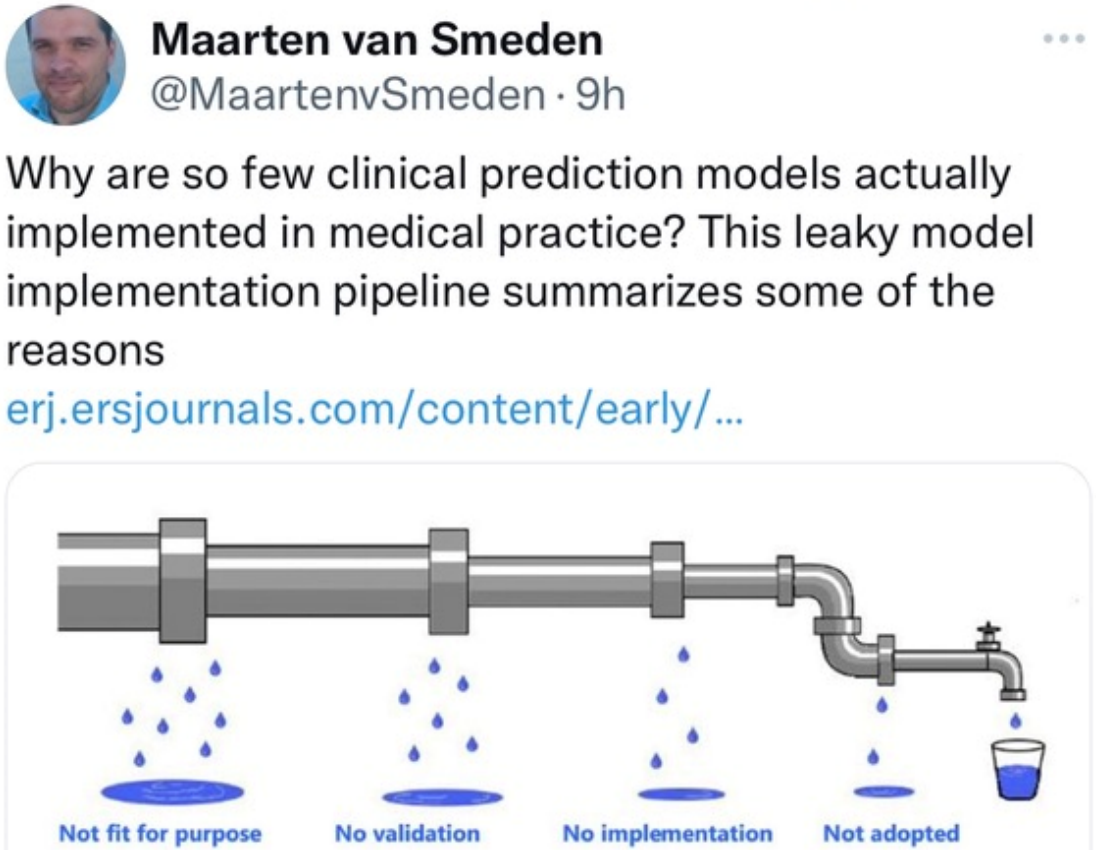


Odds Ratios and Continuous Variables

- To estimate the association and the odds ratios between a continuous variable and a binary outcome (like the presence absence of a clinical condition) such as CHD we use:

Logistic Regression

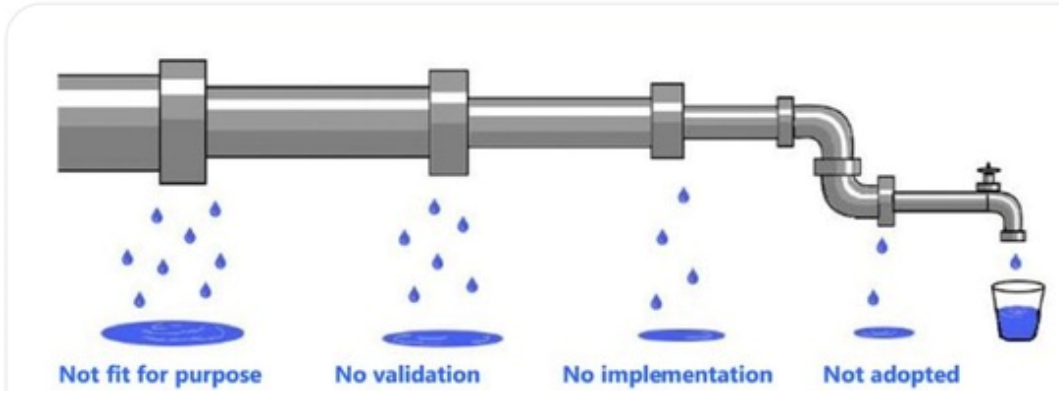
Are Clinical Decision Systems the final solution?



Are Clinical Decision Systems the final solution?

Maarten van Smeden
@MaartenvSmeden · 9h

Why are so few clinical prediction models actually implemented in medical practice? This leaky model implementation pipeline summarizes some of the reasons
erj.ersjournals.com/content/early/...



Not fit for purpose	No validation	No implementation	Not adopted
Developed on wrong patient population	Lack of data or incentive to pursue validation studies	No impact on decision making or patient (health) outcomes	Prediction (perceived as) not useful
Expensive or non-available predictors	Incompletely reported prediction model	No software developed to implement and use the model	Predictions not trusted
Time intensive to use model	Poorly developed or overfitted model	Requirements for adherence to (medical device) regulations	Model not transparent enough, or no tools available to enhance its use in practice
Outcome measured unreliably	Proprietary model code	Cost(-effectiveness) of use proprietary model	Model (perceived as) outdated