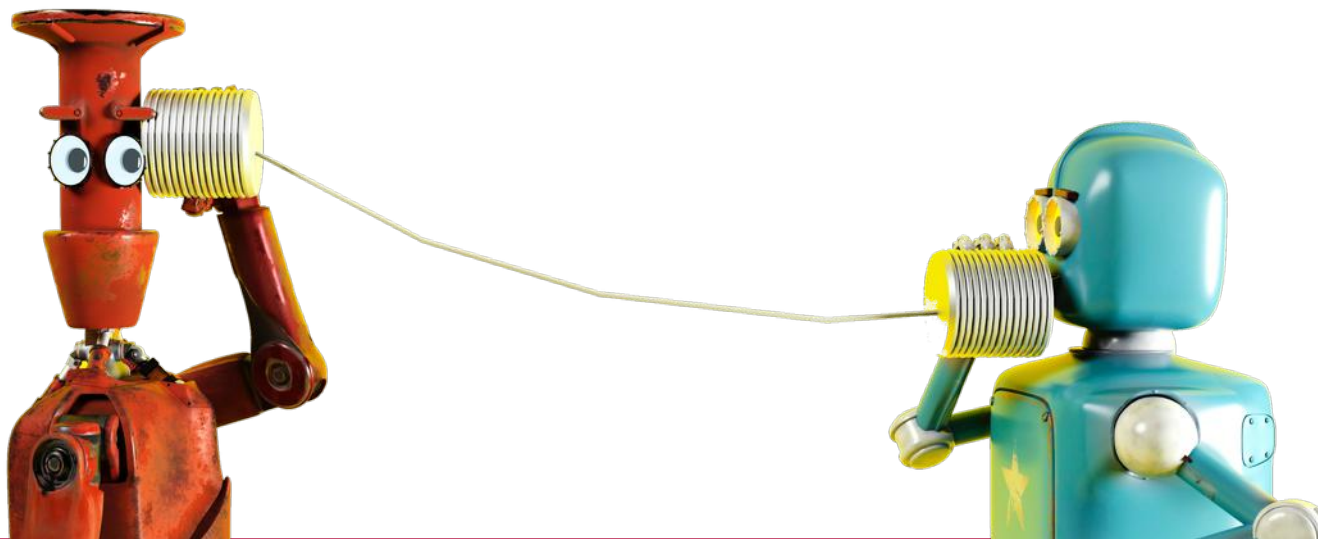




System and Human Interoperability – two faces of the same medal

dr Kai Heitmann
Berlin Metropolitan Area,
Germany
Europe



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

October 2025

Agenda

Exercises interspersed

- Interoperability? What is it...
- Introduction: Data Collection, Data Exchange, Data Use
- Standards
- Codes. Why coding?
- Excursion: Identification Schemes and Terminologies
- Standardization Organization: HL7
- A short trip: HL7 FHIR
- ...
- Interoperability in Practice

Who am I?



Dr Kai Heitmann

Medical Doctor, Medical Informatics

Standards in Healthcare IT

HL7 (Health Level 7) Germany, CEO

HL7 Europe, Expert, Community Events

- former University of Cologne
- Consultant
- Tooling Advisor and Creator ART-DECOR
- former Advisor Federal MoH Germany

info@kheitmann.de



© stock.adobe.com: Optik

Interoperability? What is it...



Introduction

Communication – Understanding

- Communication with direct contact
 - Language, gestures
 - “I can ask, if something is unclear”
- Electronic Communication
 - Certain format and structure
 - Asking back is not so easy
 - Unambiguous

Meaning (Semantics)

Structure

That fits?!

- World's Electricity Wall Plugs
 - Same Concept
 - Different Plug (Structure)
 - Different Characteristics
 - Need for "Adapters"



Semantics

Dog?





Semantics

- BMI? Body Mass Index (BMI) is a person's weight in kilograms divided by the square of height in meters. A high BMI can indicate high body fatness.
- BTU? British Thermal Unit
Brandenburgische Technische Universität
Back to University
- MPH? Master of Public Health
Miles Per Hour

Semantics and Structure

- Patient?
 - What are parts of Patient's "Data"?



Exercise

Semantics and Structure

- Patient?
 - What are parts of Patient's "Data"?

Family name

DOB

Given name

Address

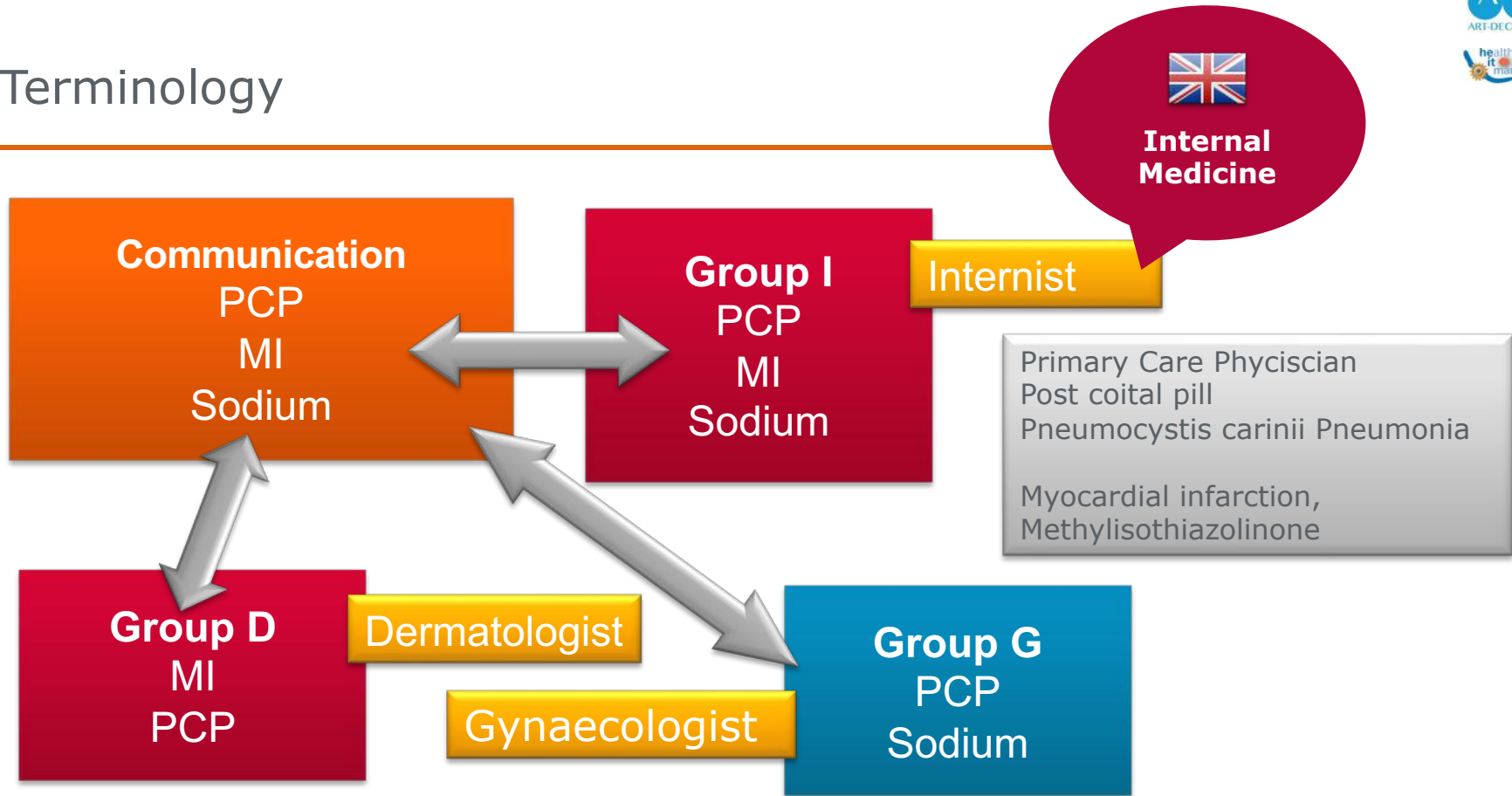
Next of kin

Gender

Insurance

Question is – maybe – not precise enough! Scope?

Terminology



Terminology

- Semantic Interoperability, Concepts and Codes, Mapping



Concepts and Codes

System IRL

mna

m

fír

f



M

F

M

F



Semantics – How codes help

Dog?

Standard dachshund (organism) 416885007



Synonyms:
sausage dog
wiener dog
Translation:
Dackel

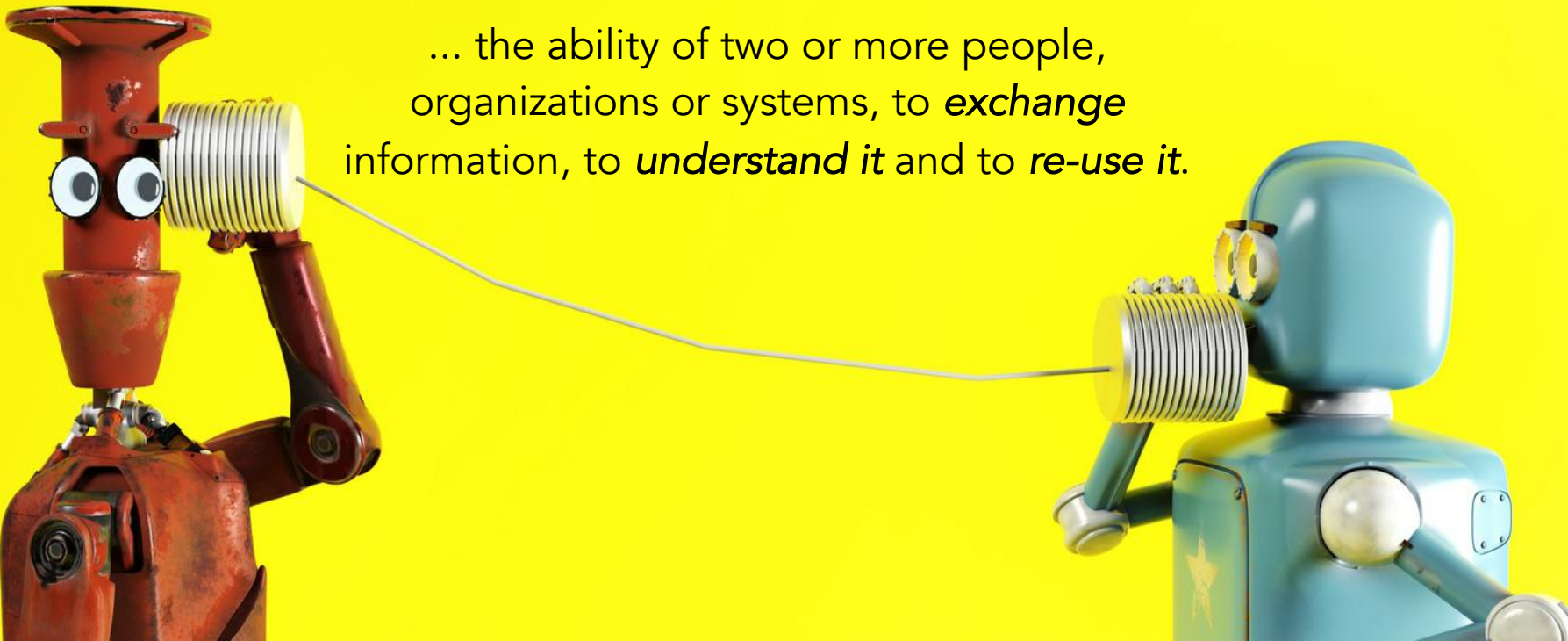
Family Canidae (organism) 106969009

SNOMED CT
The global
language of
healthcare

Translation:
Schäferhund

German shepherd dog (organism) 42252000



A red robot on the left and a blue robot on the right are connected by a thin white wire. The red robot has a large coil of wire on its head and a single eye visible. The blue robot also has a large coil of wire on its head and a single eye visible. The background is a solid yellow color.

... the ability of two or more people,
organizations or systems, to *exchange*
information, to *understand it* and to *re-use it*.

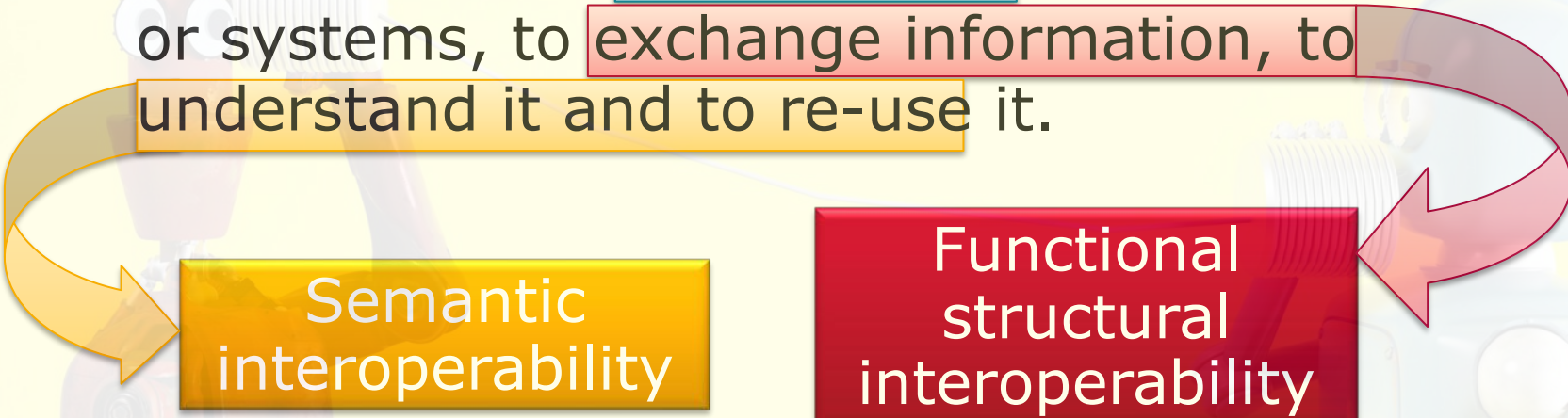
© Fotolia.de: Optinik

Interoperability is...

Enabling Semantic Interoperability

- Interoperability:

... the ability of two or more people, organizations or systems, to exchange information, to understand it and to re-use it.



Semantic
interoperability

Functional
structural
interoperability

Interoperability

- **Identical Ideas of Concepts**

What is an encounter?
- **Terminologies**

What is the code for a penicillin allergy?
- **Identification Schemes**

What is the patient identifier?
- **Definition of Structures (Content)**

What data belongs to a patient? How to exchange patient demographic data?
- **Exchange of Information**

How is data sent over the „wire“?
- **Safe Networks, Security**

How to ensure privacy, security etc.?
- **Organizations, Laws**

Jurisdictional collaboration framework

Interoperability – Three Core Colors

1

Medical Domain, Patient Care and Science

Content Process

2

Clinical Terms, Terminology, Semantic Annotation

„Language“

3

Technical Representation, Data formats, Reference- and Industry Solutions

Software Documentation

Interoperability – Three Core Colors

1

Medical Domain, Patient Care and Science

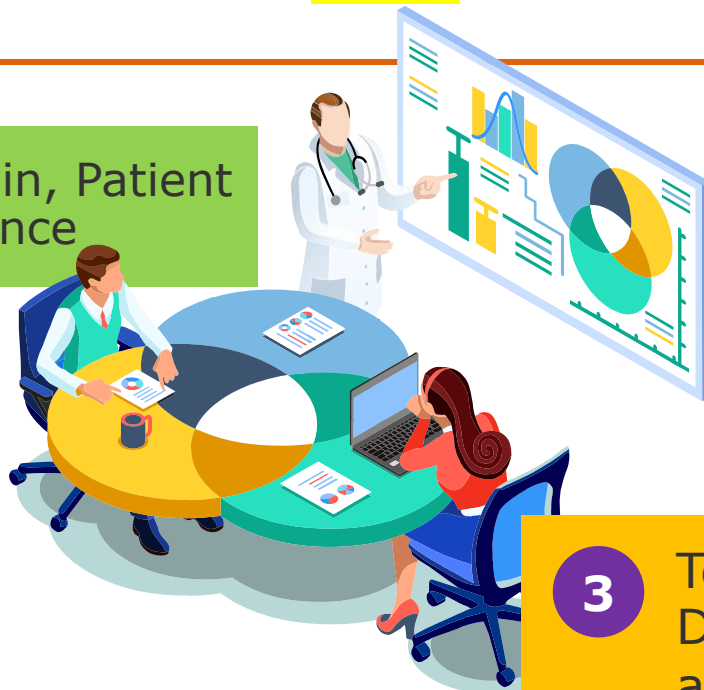
2

Clinical Terms, Terminology, Semantic Annotation

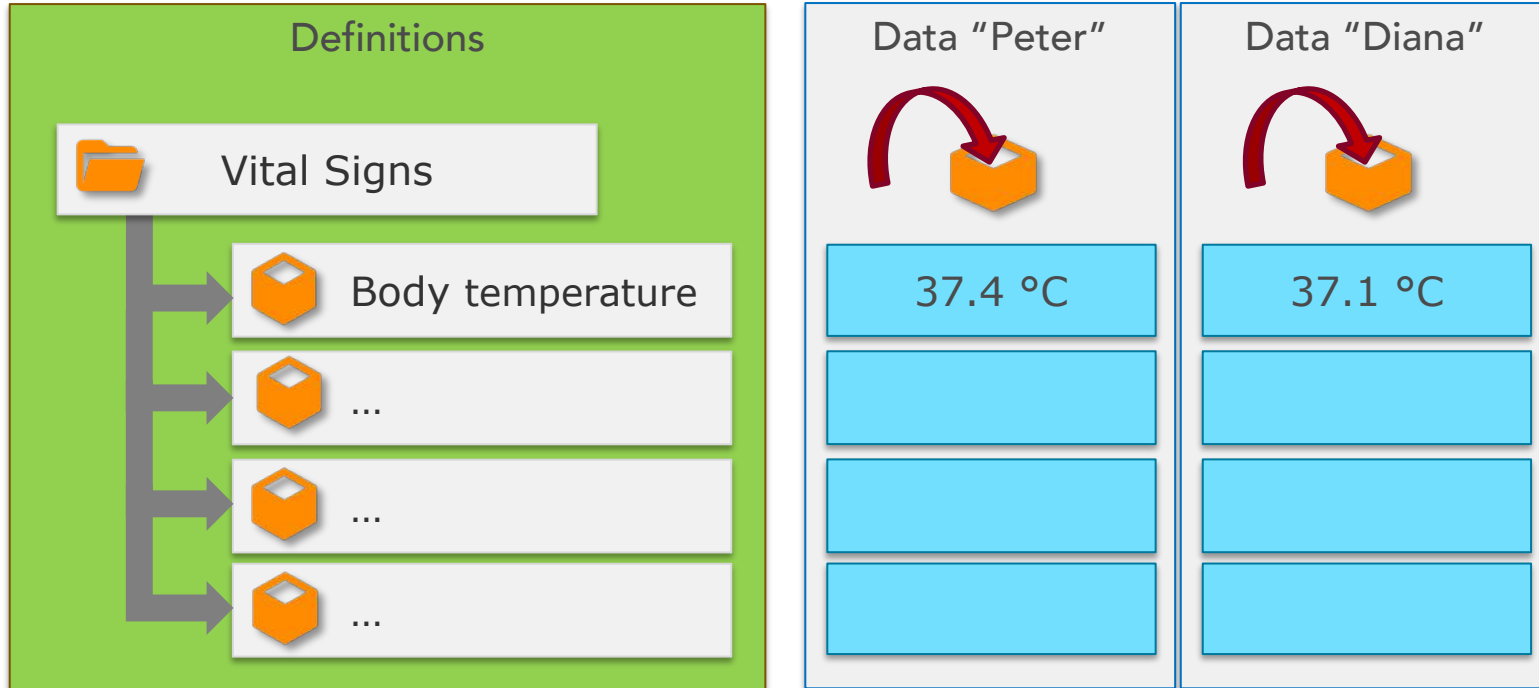
3

Technical Representation, Data formats, Reference- and Industry Solutions

... and more such as:
data protection and data security, transport, identity management, organizational and regulatory interoperability, devices, etc.



Definitions and Data



Vital Signs

- Evaluate what the term “vital signs” means in healthcare
- Collect “vital signs” names and definitions
- Think about the “properties” of such a “vital sign” from a patient / a healthcare provider perspective
- Try to gather real “vital signs” results, e. g. from yourself



Exercise

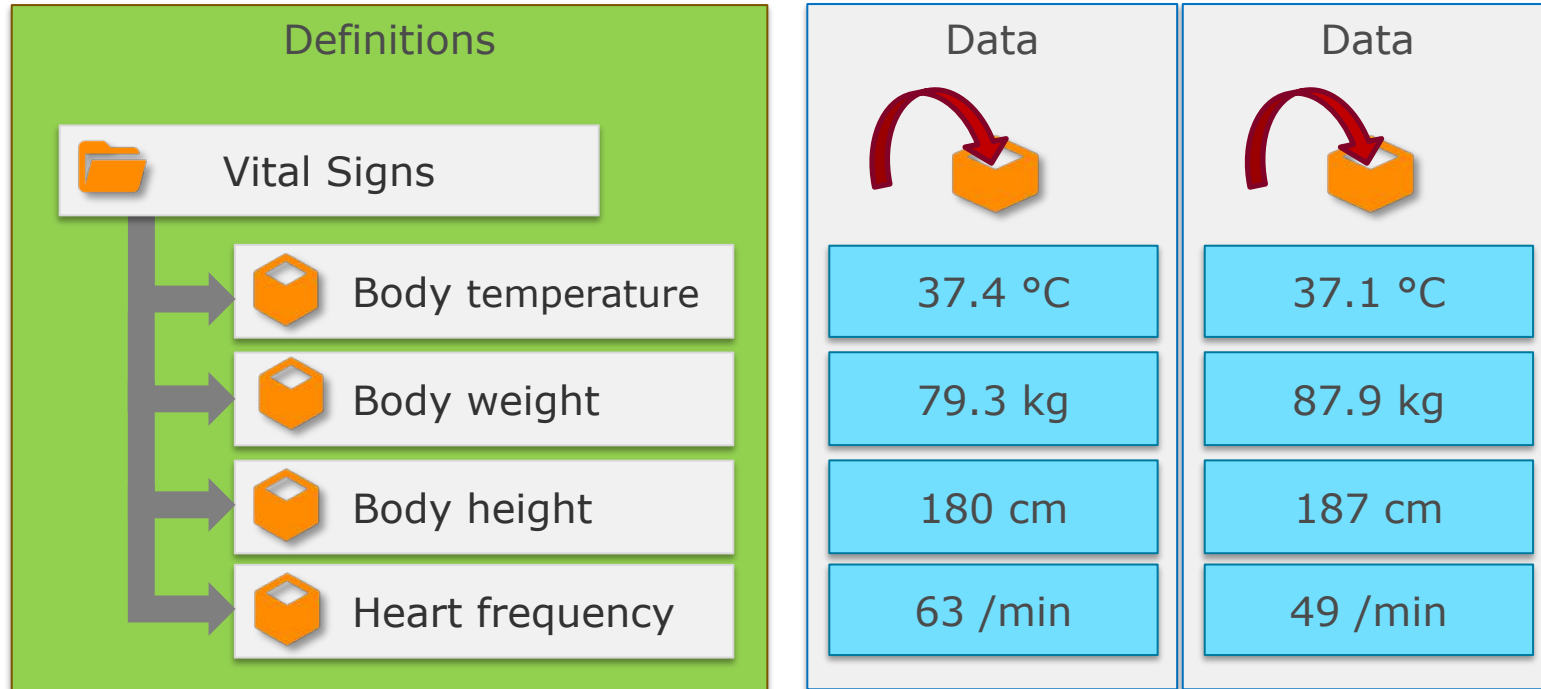
Vital Signs

- **Body temperature**
 - **Heart rate / Pulse**
 - **Respiratory rate**
 - **Blood pressure (systolic, diastolic)**
 - **Body height**
 - **Body weight**
-
- **Oxygen Saturation**
 - **Blood glucose level (fasting?)**
 - **Body Mass Index**



Exercise

Definitions and Data



Interoperability

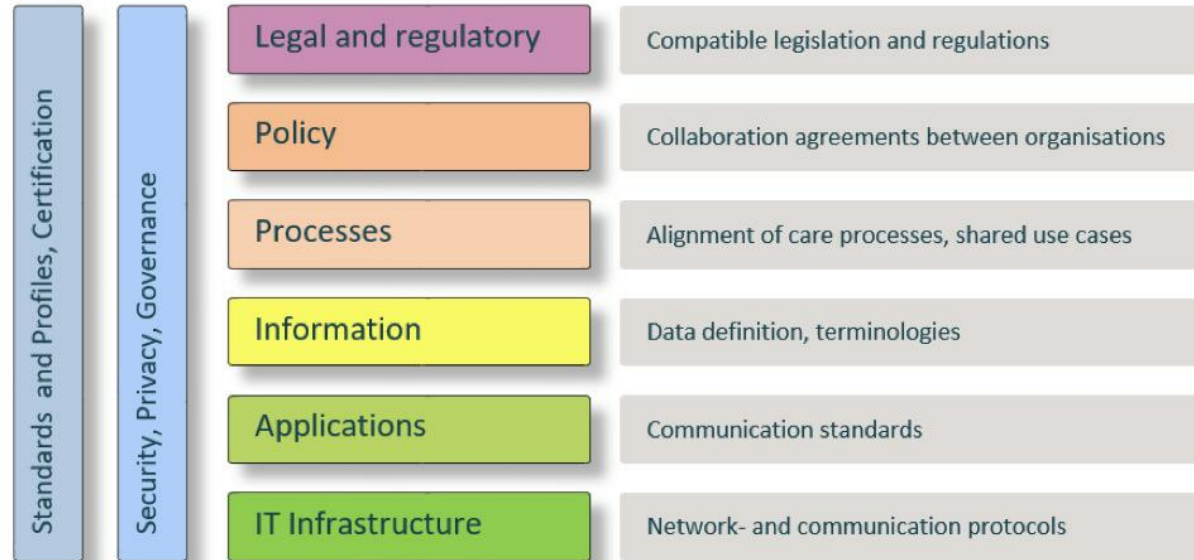
Inevitable

- Human-to-Human
 - Paper world with documents and forms
 - “simple text”
- Application Interoperability
 - Storage, Exchange, Management and Analysis of Medical Data/Information
 - Context-driven Views
 - Re-usability



Interoperability

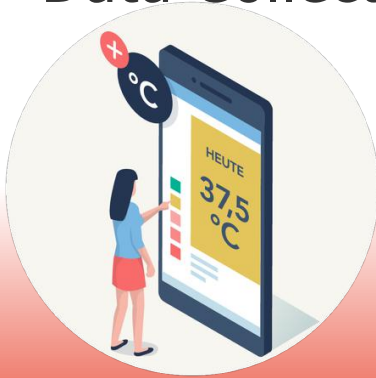
- European Interoperability Framework (EIF)**



Patient Information Journey

Interoperability → Reliably Store, Manage, Exchange and Analyze Patient Care Data

Data Collection



Data Exchange



Data Use



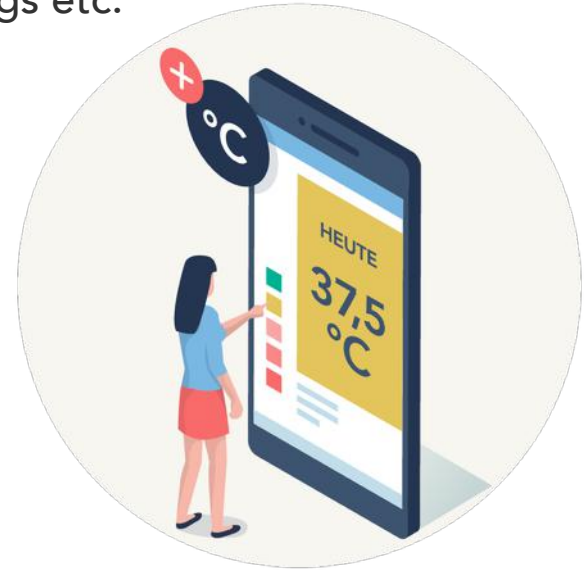
Data Collection

- In Apps, during Patient Care in Hospitals, Practice Settings etc.
 - Examples: Lab Result, Body Temperature, Symptoms such as Cough u.s.w.
- Uniquely name things
- → Terminologies!



4.5 mmol/L

271236005

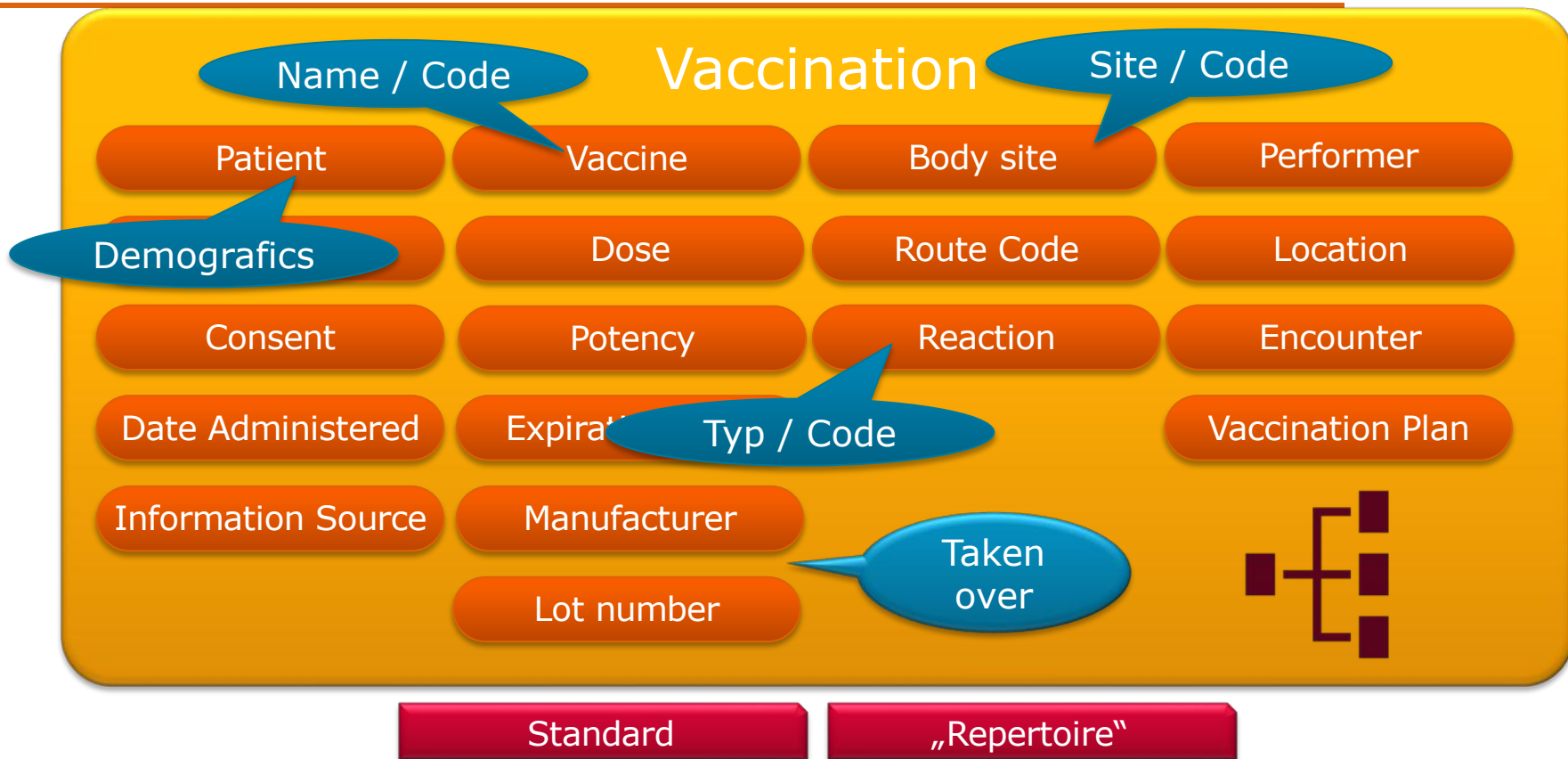


— K, Electrolytes, serum,
Potassium

Medical Domain Experts: Requirements

- Data elements, collected in Datasets
 - Example: Documentation of a Vaccination in the context of Patient Care → Medical Domain Experts
 - Glossary, Definitions
 - Standards and Context-aware Refinements (aka Profiles)
- Data models
- Dynamic Aspects
 - Actors
 - Data flow
 - Timing (Triggers)

Standards: Example "Vaccination"



Standards, Profiles, Guidelines

Standard

Patient Care

Vaccination Proof

Vaccination

Patient

...

Standards, Profiles, Guidelines

Standard

Vaccination

Patient

...

Profile **Patient Care**

Vaccination

Patient

...

Standards, Profiles, Guidelines

Standard

Vaccination

Patient

...

Profile **Patient Care**

Vaccination

Patient

...

Profile **Vacc. Proof**

Vaccination

Patient

...

Medical Domain Experts: Requirements

- How are the data items and records defined
 - What is a body temperature?
 - How is systolic blood pressure defined?
 - What types of samples are there for the laboratory?
 - What are symptoms of gallstones?



Standards, Profiles, Guidelines

Standard

Vital Signs

Patient

Vital Signs

Date

Body weight

Value

Unit

Interpret

Profile Patient Diary

Vital Signs

–

Vital Signs

Date

Body weight

Value

Profile Report to Doctor

Vital Signs

Patient

Vital Signs

Date

Body weight

Value

Unit

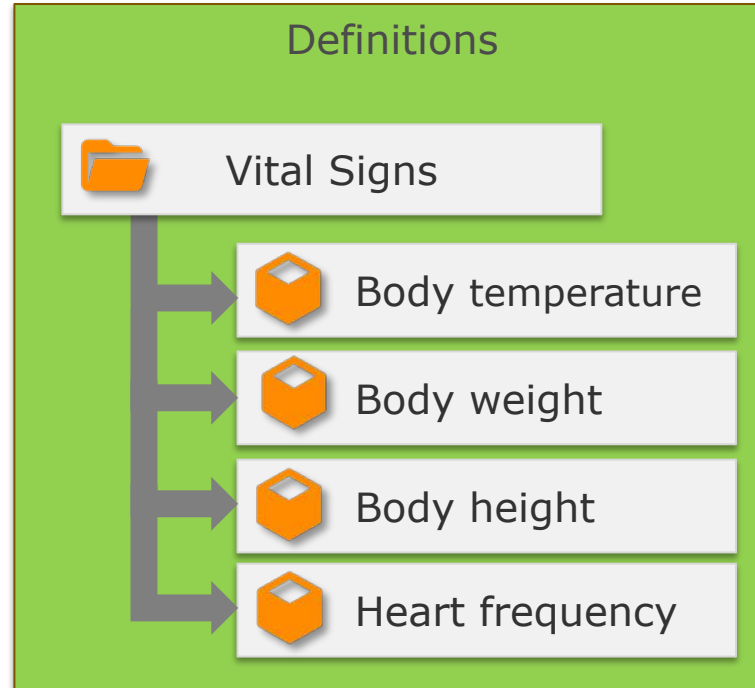
Interpret

Definitions and Data

1

Medical Domain, Patient Care and Science

- Vital signs
- Grouping
- Individual values
- Measured value and unit
- Specifications for unit
- other, e.g. B. Date of measurements



Definitions



Vital Signs



Body temperat.



Body weight



Body height



Heart frequency

Terminology



8310-5 Body temp.

3141-9 Body weight

8302-2 Body height

8867-4 Heart rate



Why Coding?

Trip to my Vietnamese Restaurant

Definitions and Data

2

Clinical Terms, Terminology, Semantic Annotation

Definitions



Vital Signs



Body temperat.



Body weight



Body height



Heart frequency

Terminology



8310-5 Body temp.

3141-9 Body weight

8302-2 Body height

8867-4 Heart rate

Menu card

HU TIÊU XÁ XIEU, TÔM

Rice Noodle Soup Sm: \$6.95 . Lg: \$7.95 . X-Lg: \$8.95

- HU TIÊU**
29. HU TIÊU TÔM CUA
Rice noodle soup with shrimp and crab stick
30. HU TIÊU THAP CAM
Combination rice noodle soup with shrimp, crab & B.B.Q. pork
31. HU TIÊU XÁ XIEU, TÔM
Shrimp & B.B.Q. pork with rice and noodle soup
32. HU TIÊU BÒ KHO
Beef Stew with rice noodle soup

MÌ Egg Noodle Soup Sm: \$6.95 . Lg: \$7.95 . X-Lg: \$8.95

33. MÌ TÔM CUA
Shrimp, crab with egg noodle soup
34. MÌ THAP CÂM
Combination egg noodle soup with shrimp, crab & B.B.Q. pork
35. MÌ XÁ XIEU, TÔM
Shrimp & B.B.Q. pork with rice and noodle soup

Small: \$6.95 . Large: \$7.95 . X-Large: \$8.95

„Number 31, please“

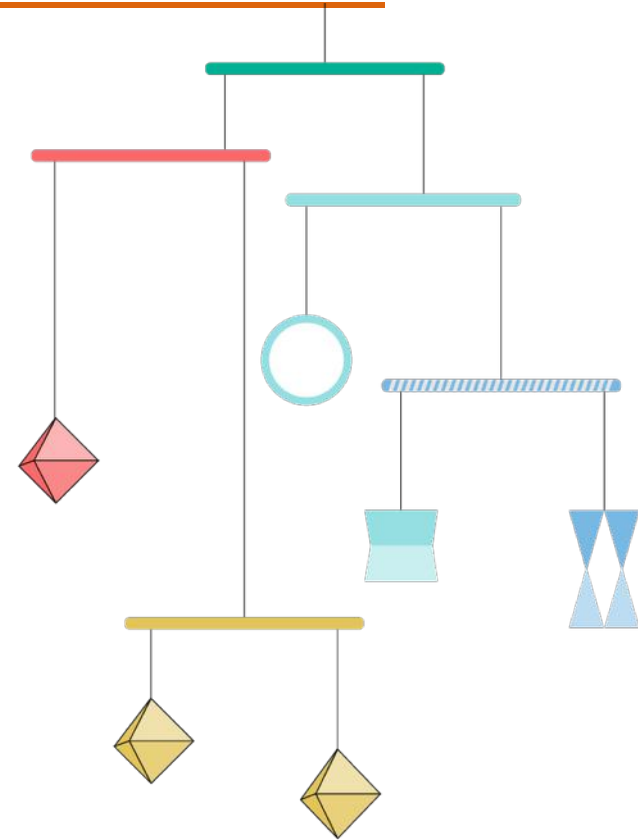
ONLY HERE!

Rice Dishes

- CƠM**
44. CƠM SU'ON NU'ONG
B.B.Q pork chop with steamed rice
45. CƠM THIT NU'ONG
B.B.Q pork with steamed rice
46. CƠM BÌ THIT NU'ONG
Shredded pork, B.B.Q pork with steamed rice
47. CƠM BÌ CHA CUA SU'ON NU'ONG
B.B.Q pork with steamed egg and steamed rice
48. CƠM BÌ CHA CUA THIT NU'ONG
Shredded pork, B.B.Q pork with steamed egg and steamed rice

The Equipped Mobile (kinetic sculpture)

- Coding for optimal human-machine cooperation
- Preferred code above
- Various other things can "hang" on it
 - synonyms
 - patient-friendly terms
 - Sorting/offering a picklist by frequency from the recent past



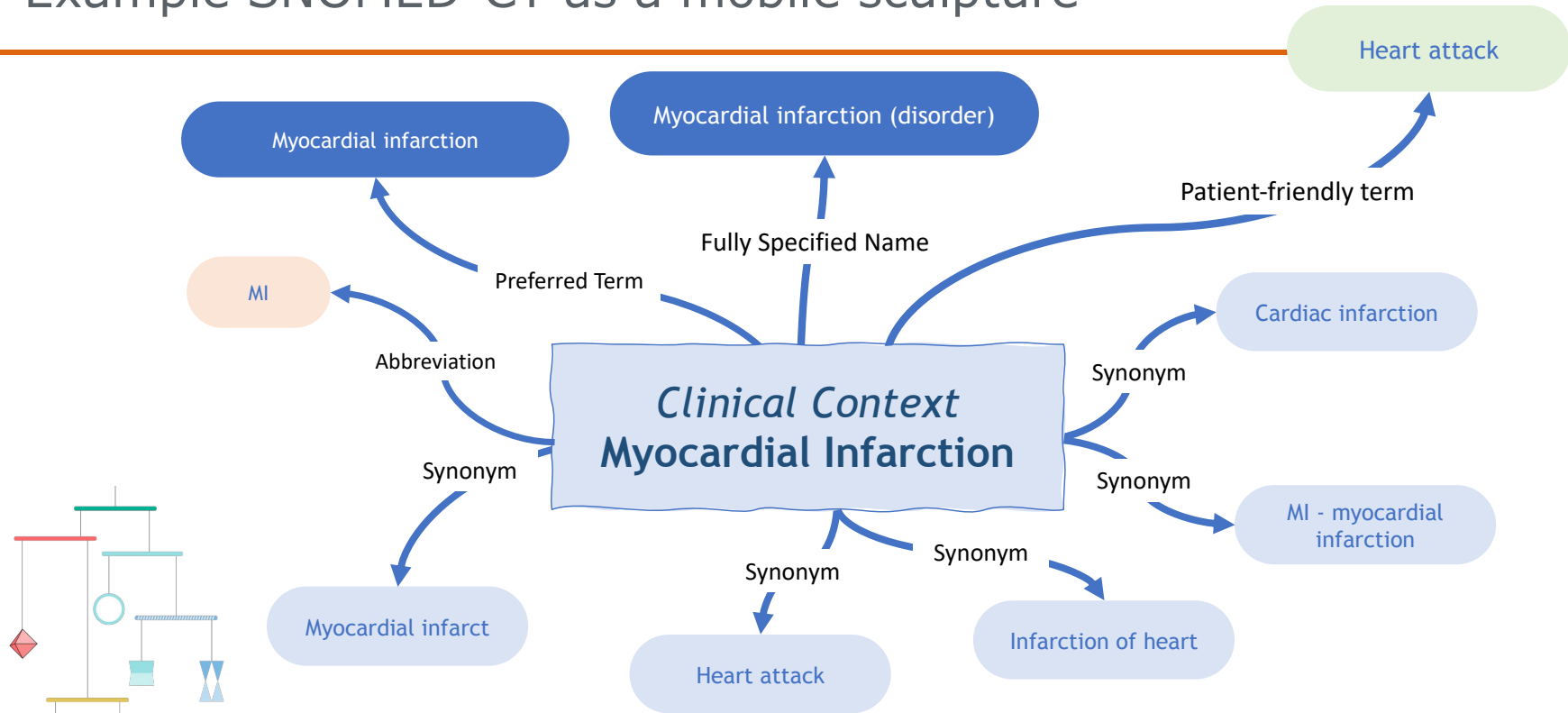
Example SNOMED-CT as a mobile sculpture

Clinical Context
Myocardial Infarction

Example SNOMED-CT as a mobile sculpture

Clinical Context
Myocardial Infarction

Example SNOMED-CT as a mobile sculpture



Data Exchange: Packaging

- Medical Domain: Item Definitions ✓
- Semantics: Coding ✓

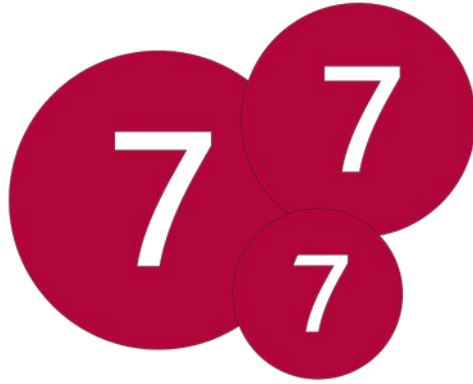
Body Temperature
SNOMED 386725007
29.04.2020 14:13
39 °C

- Standardized Packaging: Structures

Peter

Alexander





Excursion: Identification Schemes and Terminologies

Identification schemes

- Unified identification schemes:
 - Identification of real-world objects
 - Identification of software-generated objects (e.g. prescriptions, encounters)



Identification Mechanisms

- Identification mechanism: identifiers which identify an object-instance (including vocabulary tables)
 - UK: NHS Number
 - NL: BSN, paspoortnr., UZI, AGB-Z, URA
 - DE: HCP Nummer, eGK nummer (health card)
 - NO: Folkeregister nummer, HPR nummer



Terminology – The Medical Informatics dogma

- Fact: computers can only deal with a structured representation of reality:
 - structured data:
 - relational databases, spread sheets
 - structured information:
 - data formats simulates context
 - structured knowledge:
 - rule-based knowledge systems
- Conclusion: a need for structured data entry

CDA Vocabulary identification scheme

HL7 CDA example

```
<value xsi:type="CD" code="198436008"
      displayName="Menopausal flushing (finding)"
      codeSystem="2.16.840.1.113883.6.96">
</value>

<translation code="N95.1" codeSystem="2.16.840.1.113883.6.3"
      displayName="Menopausal and female climacteric states"/>
```

Code

Code System

Code

Code System

Maps

Terminology Terms

Relationships

Code

Fruit
Banana
25352004



SNOMED-CT

Code System

- Concept Domain
- Concept
- Coded Concept
 - mnemonic that identifies a semantic concept
- Code System
 - system of coded concepts used to represent semantic concepts
 - Mostly authored by one source
 - examples: ICD-10, SNOMED, LOINC
- Value Set

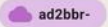
Maps

Subsets in context

Code Systems

- ICD (International Classification of Diseases)
- ICPM (International Classification of Procedures)
- LOINC (Logical Observation Identifier Names and Codes)
- SNOMED-CT
- HL7
- (UCUM, Unified Code for Units of Measure)
- ...

HL7 Code System Example

☐ AdministrativeGender  

Selected version: 2014-03-26 (1 of 2)

 2014-03-26  2011-07-26

History description 2014-03-26: Lock all value sets untouched since 2014-03-26 to trackingId 2014T1_2014_03_26

description:
The gender of a person used for administrativ...

[See more...](#)

Id	Display Name	Status	Version
1	AdministrativeGender	 Final	2014-03-26

Source Codesystems

Id	Codesystem name
2.16.840.1.113883.5.1	Administrative Gender

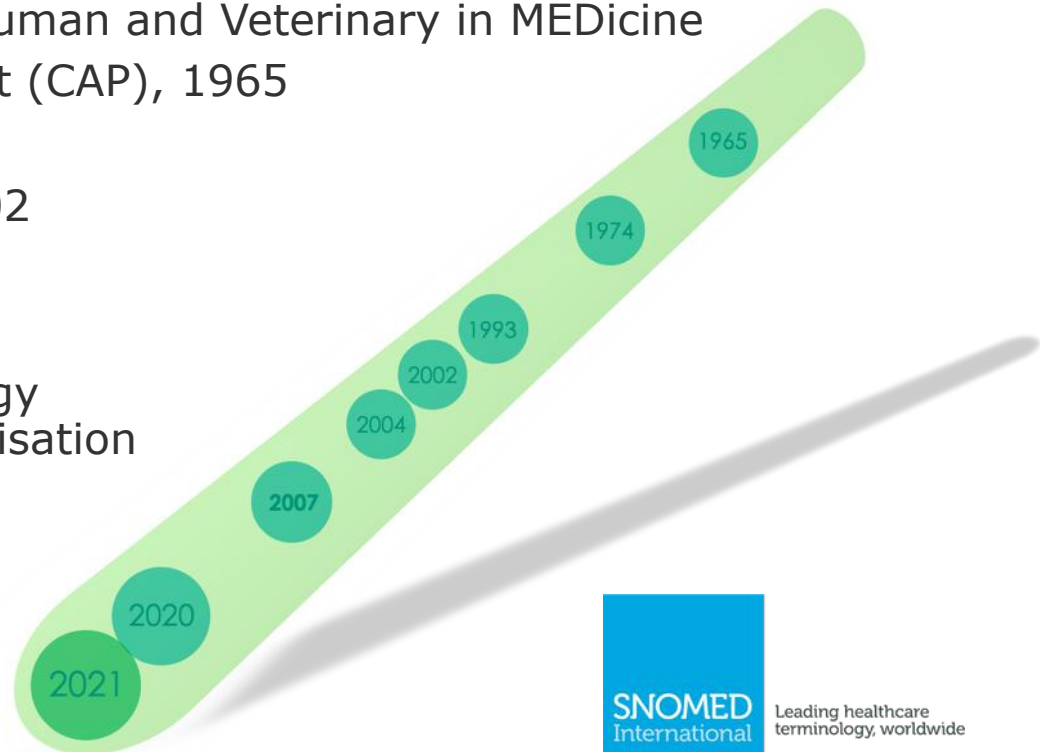
Concepts 

Level/Type	Code	Display Name / Description	Code System
0-L	F	Female	Administrative Gender
0-L	M	Male	Administrative Gender
0-L	UN	Undifferentiated	Administrative Gender

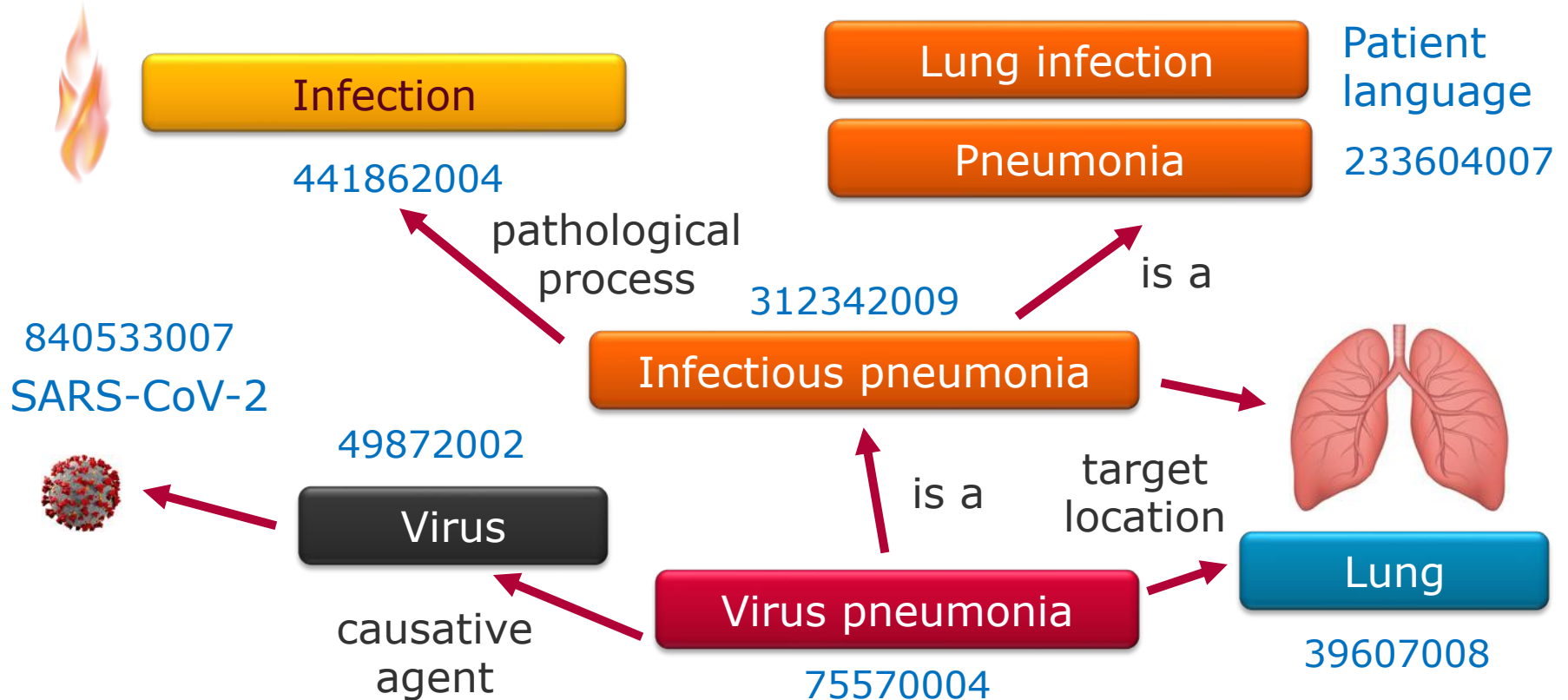
"Administrative" Gender codes

SNOMED

- Systematized NOmenclature of Human and Veterinary in MEDicine
 - College of American Pathologist (CAP), 1965
- SNOMED International 1993
- SNOMED CT (Clinical Terms): 2002
 - CAP & NHS,UK
- SNOMED CT: since 2007
 - International Health Terminology Standards Development Organisation
 - two revisions each year
- 2020: 39 member countries



Definition of Concepts and their Relationships



Terminologies/Identification Schemes

- The choice of **Vocabulary/Terminology** is important
 - Prerequisite for aggregated data sourced from multiple organizations
 - Choice of terminology: organizational/political factors

- The choice of **Identification Schemes** is important
 - Prerequisite for aggregated data sourced from multiple organizations
 - Choice of Identification Schemes: mostly determined by third parties (e.g. government, insurance companies)

Questions?

HL7[®]
International

HL7[®]
 Europe

HL7[®]
Deutschland 

Health Level 7 (HL7)

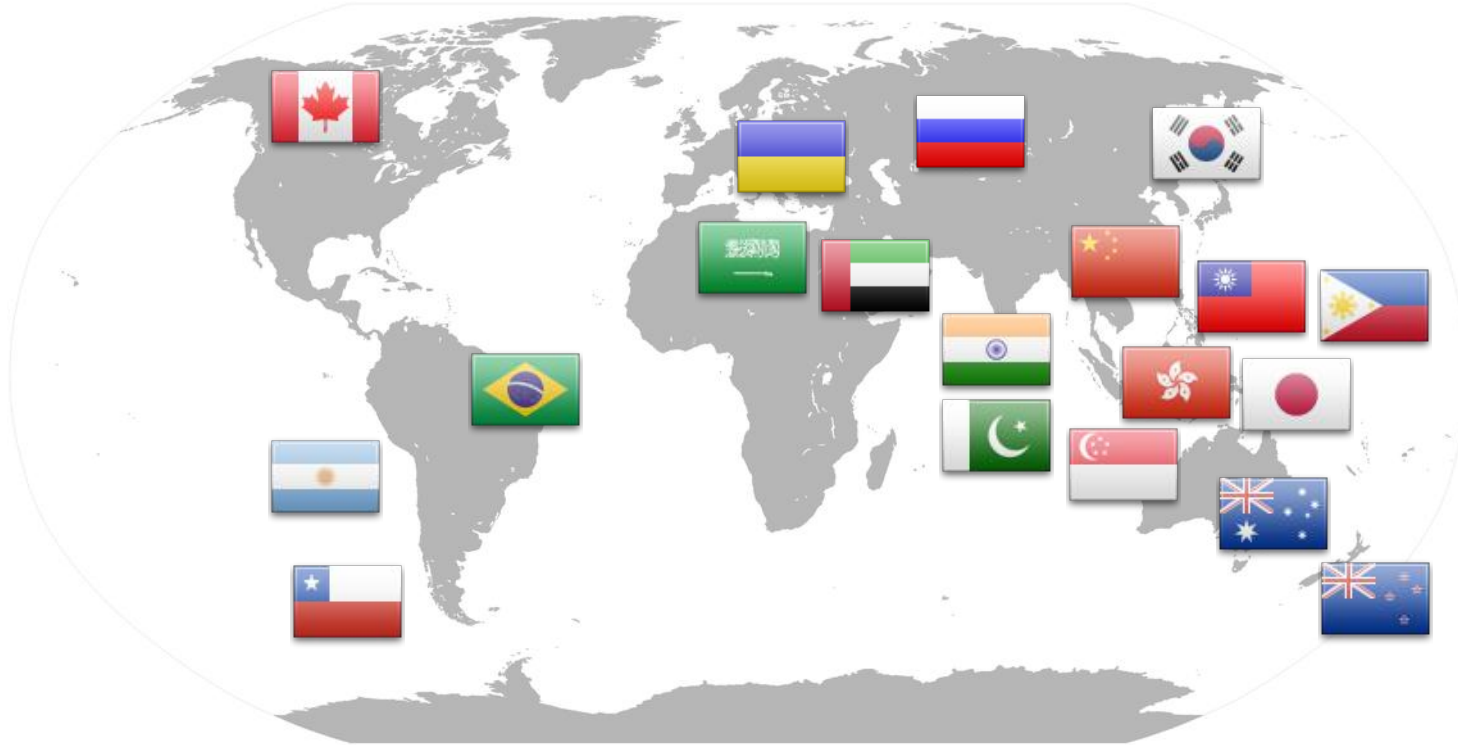
Where do HL7 standards help?

- HL7 standards assist in
 - moving healthcare information in a standardized way to the point of patient care
 - moving information within and beyond the four walls of hospitals among all healthcare stakeholders
 - the sharing of public health information
 - enabling the electronic healthcare record and the creation of national healthcare information networks

HL7 in Europe



HL7 – The World Map beyond Europe



Basic principles of HL7

- no assumptions about the software architecture
- few assumptions about the technical communication infrastructure
- implementation guides, based on the underlying standards

C
ommunicate

S
tore

A
nalyze

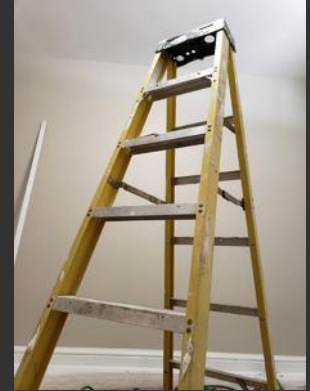
HL7: Generation of Standards

HL7 product line / generation	Standard	Subject and times
	Version 2.x	Messages (1987..) v2.xml (2003..)
	Version 3 Clinical Document Architecture (CDA)	Messages (1995..) and Services Electronic Documents (Release 1 since 1999.., Release 2 since 2005..)
	Fast Healthcare Interoperability Resources (FHIR)	Resources (2012..)

Development process of FHIR

Content proposal by domain experts
Resource definition incl. terminology
Maturity Levels express maturity
Connecathons → Ballot → Normative Standard

- in January 2018 in New Orleans – with 250 participants
- in September 2023 in Phoenix – with 340 participants



FHIR Connectathon



FHIR Connectathon

“Hacker in the room”

Part of maturity proof

Grouped by topics

Result: Experience

- ...for yourself
- ...for the standard





How are standards created

HL7 Working Groups



Meetings: Sharing Experiences

- Work Group Meeting, Conferences
- Developing the standard
- Stimulating Co-Laborations
- Institutionalizing exchange
- Culture of ideas
- Remain concerned





A short trip to a Standard product: HL7 FHIR

FHIR! What?

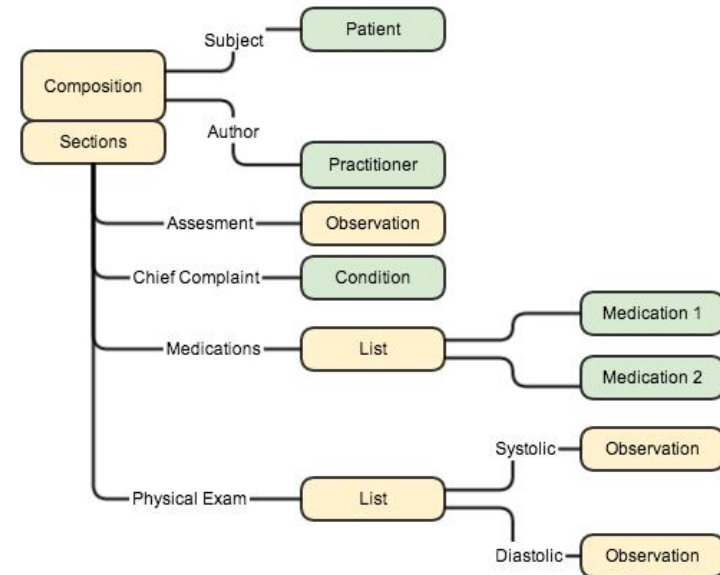
- Modular: semantic units
→ Resources
- Network of Resources
= Information / Data
- Use where?
→ modern applications...
→ future replacement of
existing solutions...

Diagnosis

Allergy

Medication

Lab result



Resource Definition

- For example Patient, and more (150)

Structure

Name	Flags	Card.	Type	Description & Constraints
 Patient			DomainResource	Information about an individual or animal record Elements defined in Ancestors: id , meta , implicit
...  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)

Data Exchange

- Technical representations (profiles) for data exchange
- ... and tips/specifications for data storage
- Format: Fast Healthcare Interoperability Resources (FHIR)
- ...used more and more in Healthcare Data Exchange (and Collection and Storage) Scenarios



Definitions and Data

3

Technical Representation

Definitions



Vital Signs



Body temperat.



Body weight



Body height



Heart frequency

Terminology



8310-5 Body temp.

3141-9 Body weight

8302-2 Body height

8867-4 Heart rate

Data formats



Observation

Observation

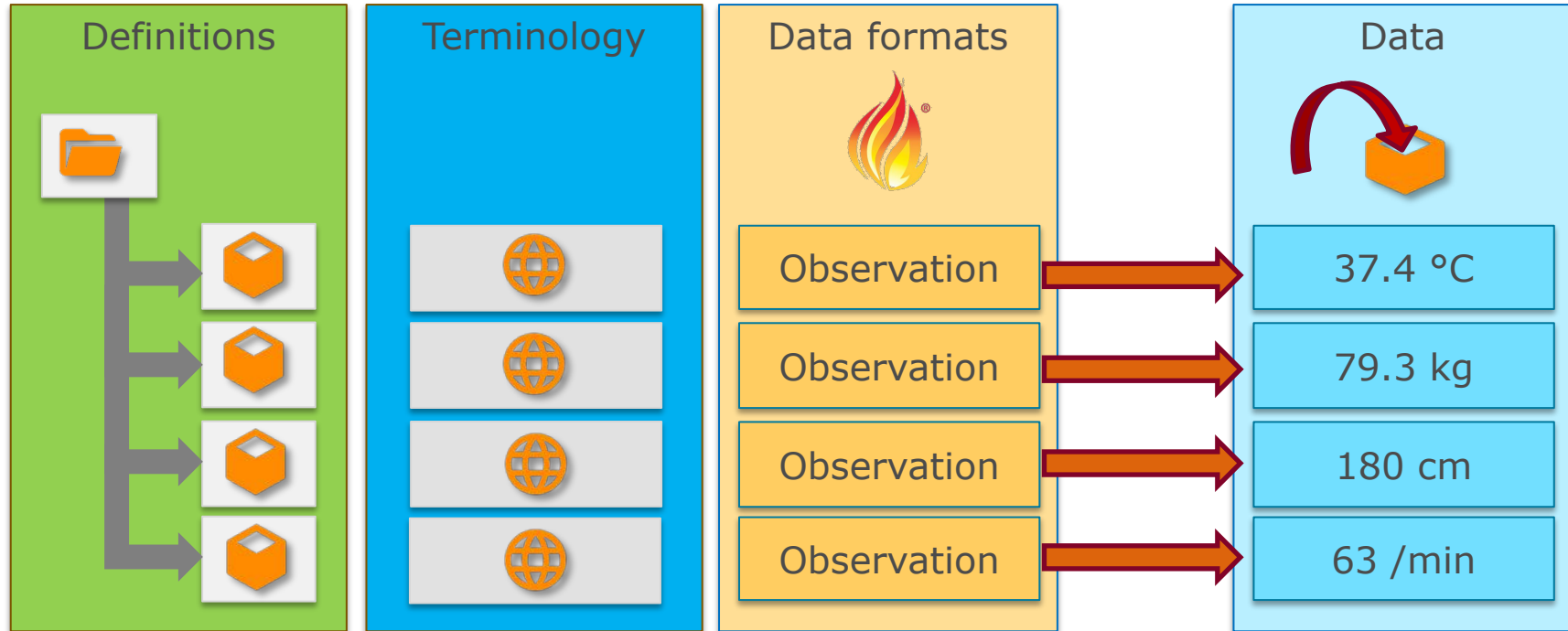
Observation

Observation

Definitions and Data

3

Technical Representation



Questions?



Emergency Data

- Assume that you are an Emergency Doctor
 - You come to a situation in Spain, where a person is lying on the floor and is not really conscious
 - Ideally: what kind of data do you want to have immediately available in this case of emergency?
-
- Please investigate all source you can reach



Exercise

Emergency Data

- Discussion of Results



Exercise

International Patient Summary – What is it?

- The International Patient Summary
- is a **minimal** and **non-exhaustive** set of **basic clinical data** of a patient,
- specialty-agnostic and condition-independent,
- but readily usable by all clinicians
- for the unscheduled (cross-border) patient care.



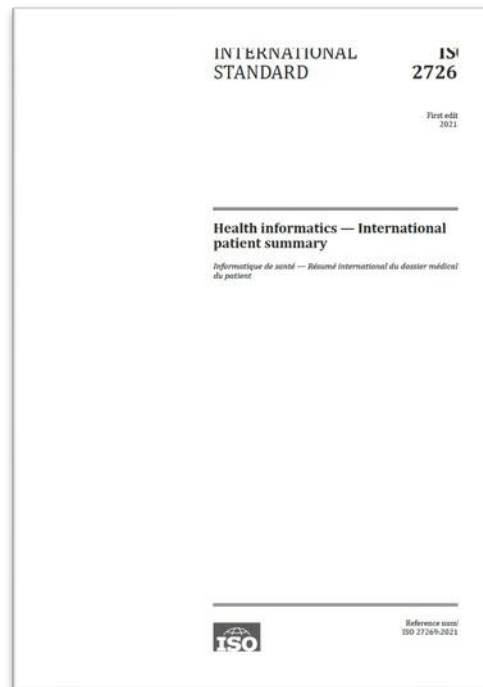
Standards for Interoperability

ISO 27269:2021(E) Health informatics — International Patient Summary

1

Medical Domain, Patient
Care and Science

Content
Process



What is in it? – IPS Content (Dataset)

- Collection influenced by previous projects and experiences
- Trillium II Survey
- SAMPLER emergency scheme
- IPS Dataset, IPS Sections
 - Required
 - Recommended
 - Optional



Topic	Count
Medication (active)	9
Problems/Medical History	7
Allergies/Intolerances	7
Implanted devices	4
Risks	3
Diagnoses	3
Immunization	3
Procedures (major)	1



SAMPLER Emergency Scheme

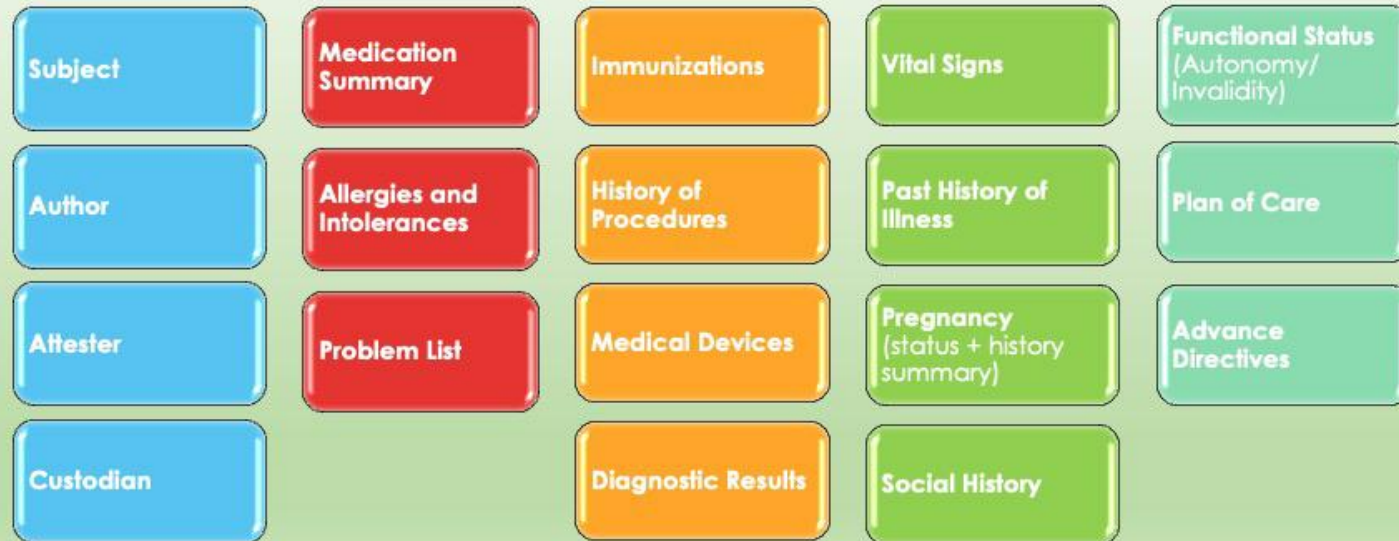
- S – Signs/Symptoms
- A – Allergies
- M – Medications
- P – Past Illnesses
- L – Last Oral Intake
- E – Events before Present Illness / Injury
- R – Risks

SAMPLER (+S)	
S Symptoms	Symptoms (Symptome) Aktuelle Beschwerden und Schmerzen Spezifische Abfrage der Symptomatik (Schmerzen) mithilfe des OPQRST-Schemas
A Allergies	Allergies (Allergien) Allergien oder Unverträglichkeiten? Gegen ... Insekten? Antibiotika? Medikamente?
M Medication	Medication (Medikation) Dauermedikation? Gerinnungshemmer?
P Past Medical History	Past Medical History (Medizinische Vorgeschichte) Vorerkrankungen? Operationen? Genetische Disposition?
L Last	Last ... (letzte ...) Mahlzeit, Stuhlgang, Wasserlassen, Regel, Krankenhausaufenthalt, etc.
E Events	Events (Ereignisse) Was war vor dem Vorfall? Was hat den Vorfall ausgelöst?
R Risk Factors	Risk Factors (Risikofaktoren) Risikogruppe? Diabetiker? Alkoholismus? Drogenabusus?
+S	Schwangerschaft Mögliche Schwangerschaft bei weiblichen Patienten in Betracht ziehen!

Source: my colleagues, Wikipedia, see also
<https://www.theemtspot.com/understanding-the-sample-history/>

International Patient Summary „Composition“

IPS Content → Composition



„Header“

Required

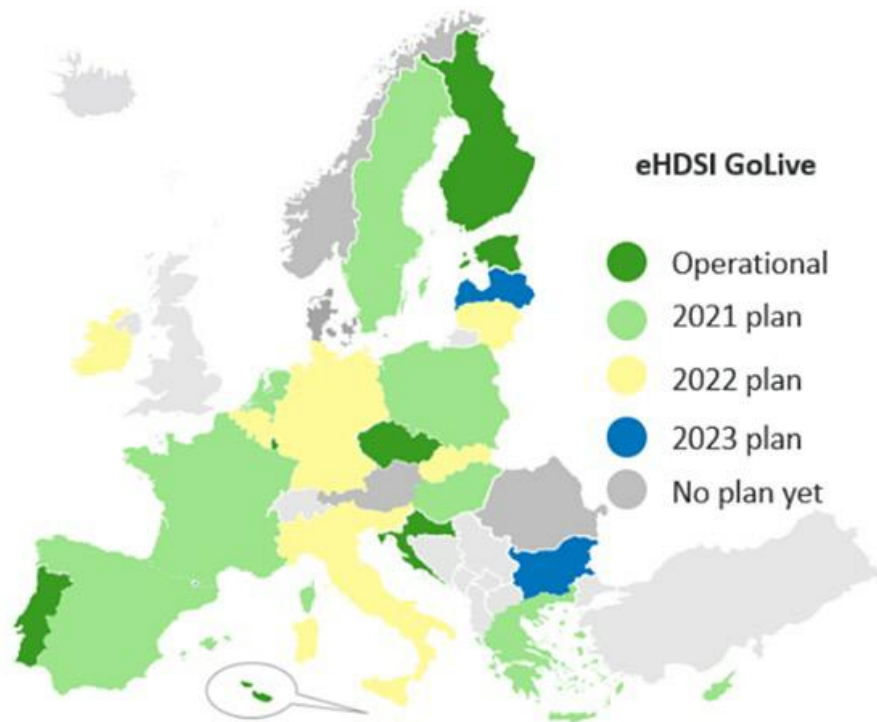
Recommended

Truely optional

Text-only

Where is it? Europe?

- Exchange of Patient Summaries has reached production usage within European nations participating in the MyHealth@EU (formerly eHDSI).
- Additional nations plan to adopt in the coming years
- Image from 2021 eHealth Network Meeting



Where is it?

- ...in your pocket?
- Why not!
- IPS as a crystallization point for **interoperable, minimal and non-exhaustive** set of **basic clinical data** of a patient



*My beloved one's were
asking me if I have
such a thing...
--Kai Heitmann*



Emergency Data

- Look at the three mandatory data sections of a proper IPS



- Please make a list of what data items in detail shall be recorded for
 - Medication of a Patient
 - Allergies of a Patient
 - Problems of a Patient

**Medication
Summary**

**Allergies and
Intolerances**

Problem List



Exercise

Emergency Data

- Discussion of Results



Exercise

Questions?

Thank you!



Dr Kai Heitmann
info@kheitmann.de