Mahidol University
Faculty of Medicine Ramathibodi Hospital
Department of Clinical Epidemiology and Biostatistics

The **F**ast **H**ealthcare **I**nteroperability **R**esource FHIR standard

AND

Data representation and processing

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➢ **Interoperability**

➢ **The Fast Healthcare Interoperability Resource (FHIR) standard**

➢ **Data representation and processing in Rajkomar A, et al. NPJ Digit Med. 2018;1:18.**

➢ **Summary**

Interoperability

HOSPITALS

PHYSICIANS

HEALTHCARE ASSOCIATION

REGISTRIES

LABORATORIES

HEALTH PLANS

EMPLOYERS

APPLICATION PROVIDER

Definition

- is the <u>ability</u> of different information technology systems and software applications to <u>communicate</u>, <u>exchange data</u>, and <u>use</u> the information that has been exchanged

- means the ability of health information systems to work together within and across organizational boundaries in order to advance the health status of, and the effective delivery of healthcare for, individuals and communities

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Why do we need standard?
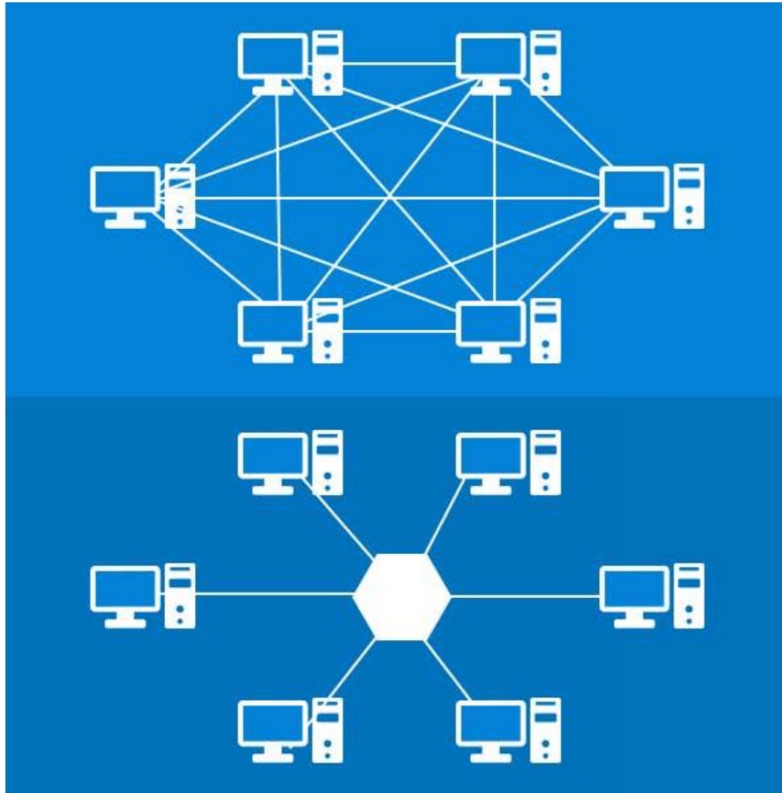
Without standard

Number of connections = n (n-1) / 2

6 nodes = 15 connections

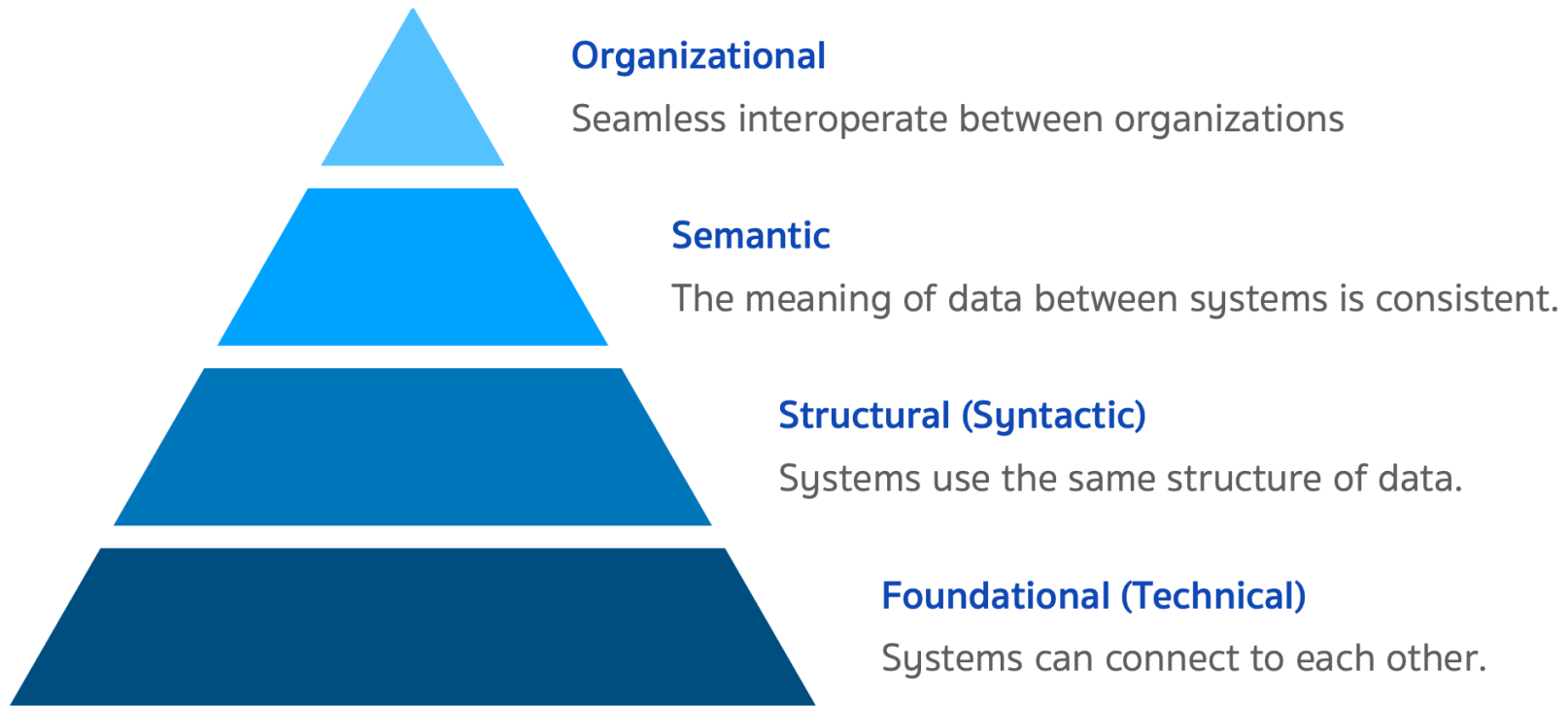100 nodes = 4,950 connections

With standard

6 nodes = 6 connections

100 nodes = 100 connections

Credit: Dr. Rath Panyowat
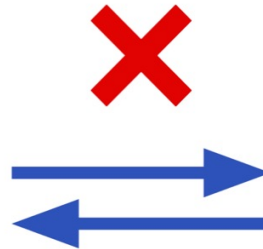
Levels of interoperability

Organizational

Seamless interoperate between organizations

Semantic

The meaning of data between systems is consistent.

Structural (Syntactic)

Systems use the same structure of data.

Foundational (Technical)

Systems can connect to each other.

Credit: Dr. Rath Panyowat

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Example of structural interoperability

First Name = "Rath"

Last Name = "Panyowat"

Contact = {

   Phone = "088-888-8888"

}

Diagnosis = "Flu"

Name = "Rath Panyowat"

Mobile = "088-888-8888"

Principal Diagnosis = "Flu"
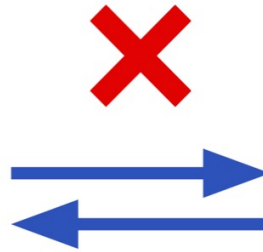
Credit: Dr. Rath Panyowat

Example of semantic interoperability (1)

Name = "Rath Panyowat"

Gender = "Male"

Disease = "Myocardial Infarction"

✖

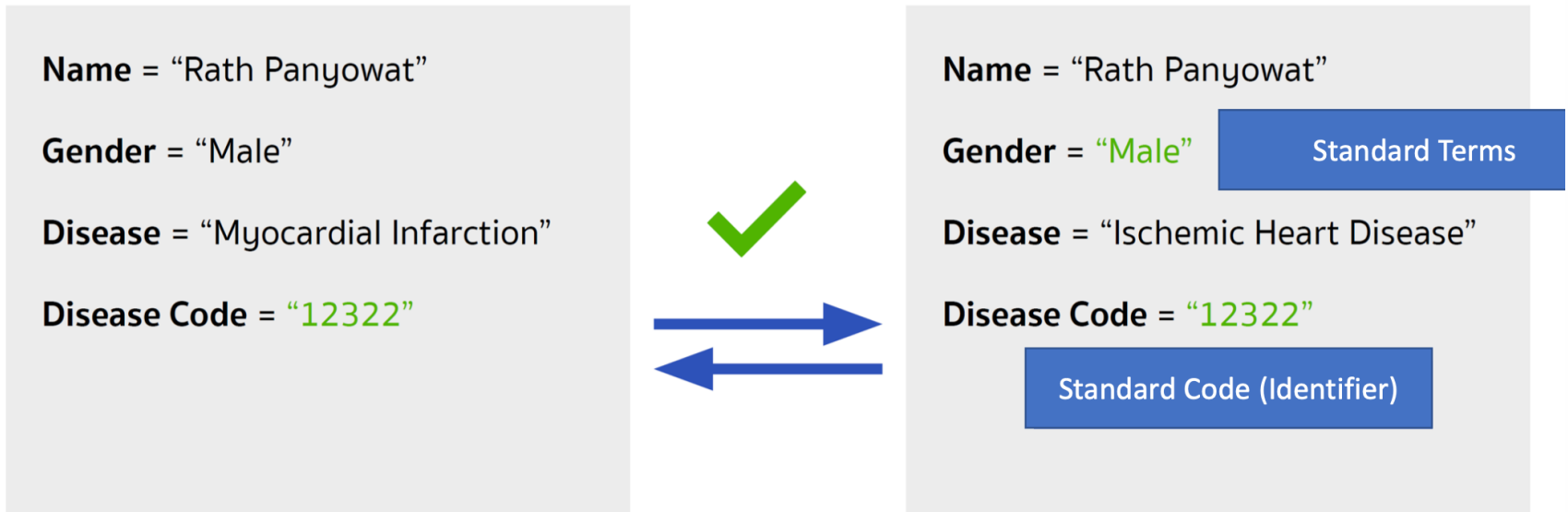Name = "Rath Panyowat"

Gender = "M"

Disease = "Ischemic Heart Disease"

Credit: Dr. Rath Panyowat

Example of semantic interoperability (2)

Solutions

Left	Right
Name = "Rath Panyowat"	**Name** = "Rath Panyowat"
Gender = "Male"	**Gender** = "Male" Standard Terms
Disease = "Myocardial Infarction"	**Disease** = "Ischemic Heart Disease"
Disease Code = "12322"	**Disease Code** = "12322"
	Standard Code (Identifier)

Credit: Dr. Rath Panyowat

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Level and standard

Process/Service	Clinical Practice Guideline, Similar Claim Rules (DRG), HIPAA rules	
Semantic	Health ID, ICD 10, Drug Code (TMT), LOINC, SNOMED-CT etc.	**HL7 FHIR** Fast Health Interoperability Resources
Syntactic	• HL7 V2 ,HL7 CDA, DICOM etc.	
Structure	• Standards Dataset : Discharge Summary, Prescription etc.	
Technical	• Oauth2, JSON, XML, PKI, SSL , Web Service (API) etc.	

Adapted :1) Benson T: *Principles of Health Interoperability HL7 and SNOMED*. 2nd ed. 2012. Springer; 2012., 2) Bobel B: *Making Hospital IT Interoperable* Hospital Information Technology Europe 2008

Credit: Dr. Boonchai Kijsanayotin

Fast **H**ealthcare **I**nteroperability **R**esources

Overview

- Defines how healthcare information can be exchanged between different computer systems regardless of how it is stored in those systems.

- FHIR's development began in 2012

- A Standard Development Organization (SDO) that developed many standards in the healthcare and established in 80s.

- For example, HL7 V2®, V3®, CDA®, and FHIR®

- It's not a next version of the previous HL7 standard (V2, V3), although it uses some terminology from them.

- The license is "No Rights Reserved" which means anyone can use the standard without license fee.

Specification

- **Content model**

- Exchange mechanism

- Extension framework

- Data type

- Others

2.1.0 **Documentation Index**

FHIR Infrastructure ⧉ Work Group	Maturity Level: N/A	Standards Status: Informative

This page provides an index to the key commonly used background documentation pages for FHIR. Also, see the list of 157 resources defined by FHIR.

Framework

- Conformance Rules N
- Resource Life Cycles
- References between Resources N
- Compartments
- Narrative N
- Extensibility N
- Terminologies N
  - Code Systems
  - Value Sets
  - Terminology Service
- FHIR NPM Packages
- FHIRPath N, Patch, & X-FHIR-Query
- Mappings to other standards

Version Management

- Change Management & Versioning N
- Managing Multiple FHIR Versions
- Version History
- Differences to Release 4
- Transforms between Release 4 and Release 5

Exchanging Resources (and how to choose)

- **RESTful API (HTTP)** N
  - Search N (Search Param Registry)
  - Operations N
  - Asynchronous Use
  - Using GraphQL
  - Operations for Large Resources
- Documents
- Messaging
- Services
- Persistence/Data bases
- Subscriptions Framework

Resource Definitions: N

- Resource Formats: N
- UML Definition N
- XML Format N
- JSON Format N
- ND-JSON Format N
- RDF Definition

Datatypes N

Adopting & Using FHIR

- Profiling FHIR N
- Implementation Obligations
- FHIR Workflow
- Downloads - Schemas, Code, Tools
- Managing Multiple FHIR Versions
- Validating Resources
- Logical models
- Best Practices for Implementers
- Mapping Language (tutorial)
- Testing Implementations

Safety & Security
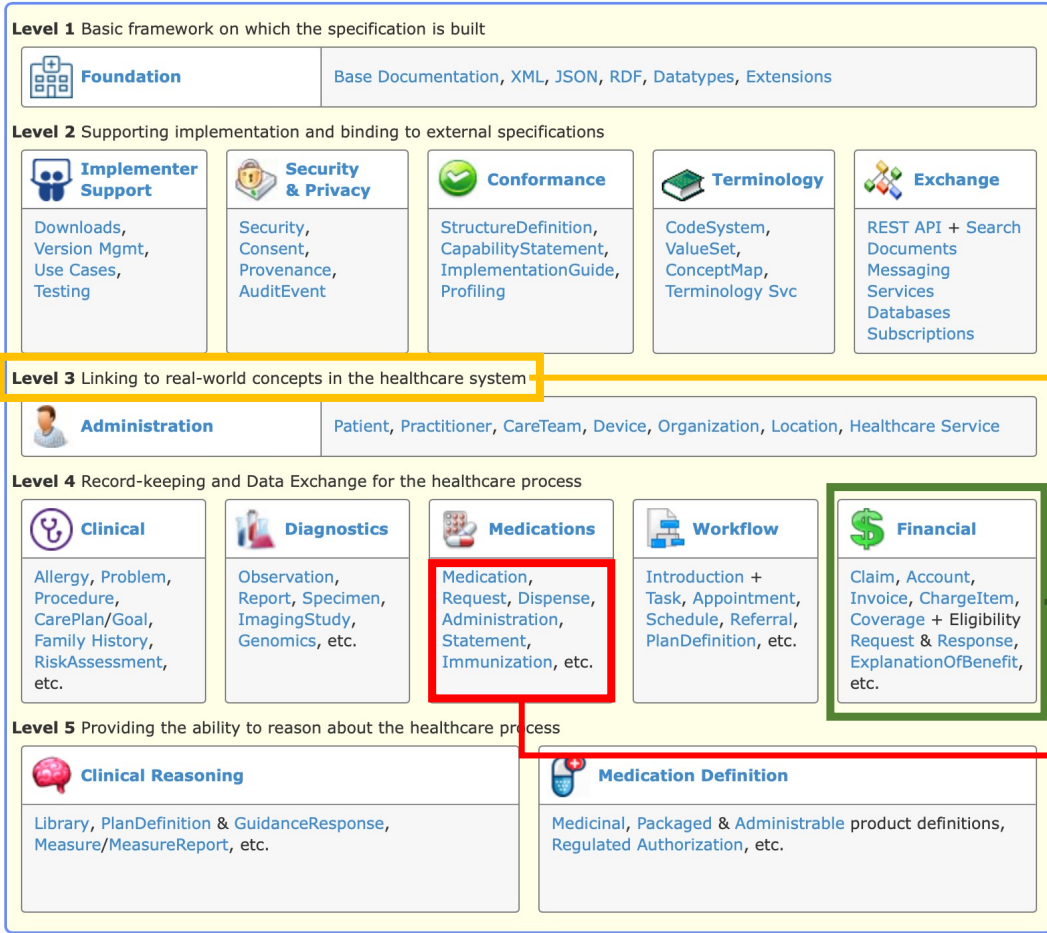
- Security, Security Labels & Signatures
- Clinical Safety

Implementation Advice

- Managing Resource Identity
- Guide to Resources
- Multi-language support
- Variations between Submitted data and Retrieved data

Content model

- 5 level
- 13 Module
- 145 resources

Level

Module

Resource

Example of medication resource (1)

11.5 Resource Medication - Content

Pharmacy ☑ Work Group	Maturity Level: 4	Trial Use	Security Category: Business	Compartments: No defined compartments

This resource is primarily used for the identification and definition of a medication, including ingredients, for the purposes of prescribing, dispensing, and administering a medication as well as for making statements about medication use.

11.5.1 Scope and Usage

Representing medications in most healthcare settings is a matter of identifying an item from a list and then conveying a reference for the item selected either into a patient-related resource or to other applications. Additional information about the medication is frequently provided for human verification (e.g., the product name), but a full representation of the details of composition and efficacy of the medicine is conveyed by referring to drug dictionaries by means of the codes they define. There are some occasions where it is necessary to identify slightly more detail, such as when dispensing a package containing a particular medication requires identification both of the medicine and the package at once. There are also some occasions (e.g. custom formulations) where the composition of a medicine must be represented. In these cases, the ingredients of the medicine must be specified together with the amount contained, though the Medication resource does not provide full details.

The Medication resource allows for medications to be characterized by the form of the drug and the ingredient (or ingredients), and how it is packaged. The medication will include the ingredient(s), and their strength(s) and the package can include the amount (for example, number of tablets, volume, etc.) that is contained in a particular container (for example, 100 capsules of Amoxicillin 500mg per bottle).

The Medication resource can be used to describe a compounded (aka extemporaneous or magistral) product that is manufactured by the pharmacy at the time of dispensing. In this case there will be multiple ingredients which are typically base chemicals (for example, hydrocortisone powder) and there may be other ingredients that are manufactured products (for example, Glaxal Base).

When a medication includes a package, further details about the composition can be provided. A package has a container (vacuum packed box, jar, etc.) and a list of the products or other packages that are in the package.

11.5.2 References to this Resource

- Resource References: ActivityDefinition, AdverseEvent, ChargeItem, ChargeItemDefinition, ClinicalUseDefinition... Show 20 more

Example of medication resource (2)

11.5.3 Resource Content

| Structure | UML | XML | JSON | Turtl— | | |

Structure

Element

Name	Flags	Card.	Type	Description & Constraints	?
Medication	TU		DomainResource	Definition of a Medication	
				Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension	
identifier	Σ	0..*	Identifier	Business identifier for this medication	
code	Σ	0..1	CodeableConcept	Codes that identify this medication Binding: SNOMED CT Medication Codes (Example)	
status	?! Σ	0..1	code	active | inactive | entered-in-error Binding: Medication Status Codes (Required)	
marketingAuthorizationHolder	Σ	0..1	Reference(Organization)	Organization that has authorization to market medication	
doseForm		0..1	CodeableConcept	powder | tablets | capsule + Binding: SNOMED CT Form Codes (Example)	
totalVolume	Σ	0..1	Quantity	When the specified product code does not infer a package size, this is the specific amount of drug in the product	
ingredient		0..*	BackboneElement	Active or inactive ingredient	
item		1..1	CodeableReference(Substance | Medication)	The ingredient (substance or medication) that the ingredient.strength relates to Binding: SNOMED CT Medication Codes (Example)	
isActive		0..1	boolean	Active ingredient indicator	
strength[x]		0..1		Quantity of ingredient present Binding: Medication Ingredient Strength Codes (Preferred)	
strengthRatio			Ratio		
strengthCodeableConcep			CodeableConcept		
strengthQuantity			Quantity		
batch		0..1	BackboneElement	Details about packaged medications	
lotNumber		0..1	string	Identifier assigned to batch	
expirationDate		0..1	dateTime	When batch will expire	
definition		0..1	Reference(MedicationKnowledge)	Knowledge about this medication	

Example of medication resource (3)

Resource

Element	Element	Extension
Element	Element	Extension
Element	Element	

- Not fit our need
- We can customize it to fit our context.

Following the rules
- Terminology Binding
- Gender (male/ female/ other/ unknow))
- Drug code (e.g., SNOMED CT)

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HL7 FHIR ®
(cont.)
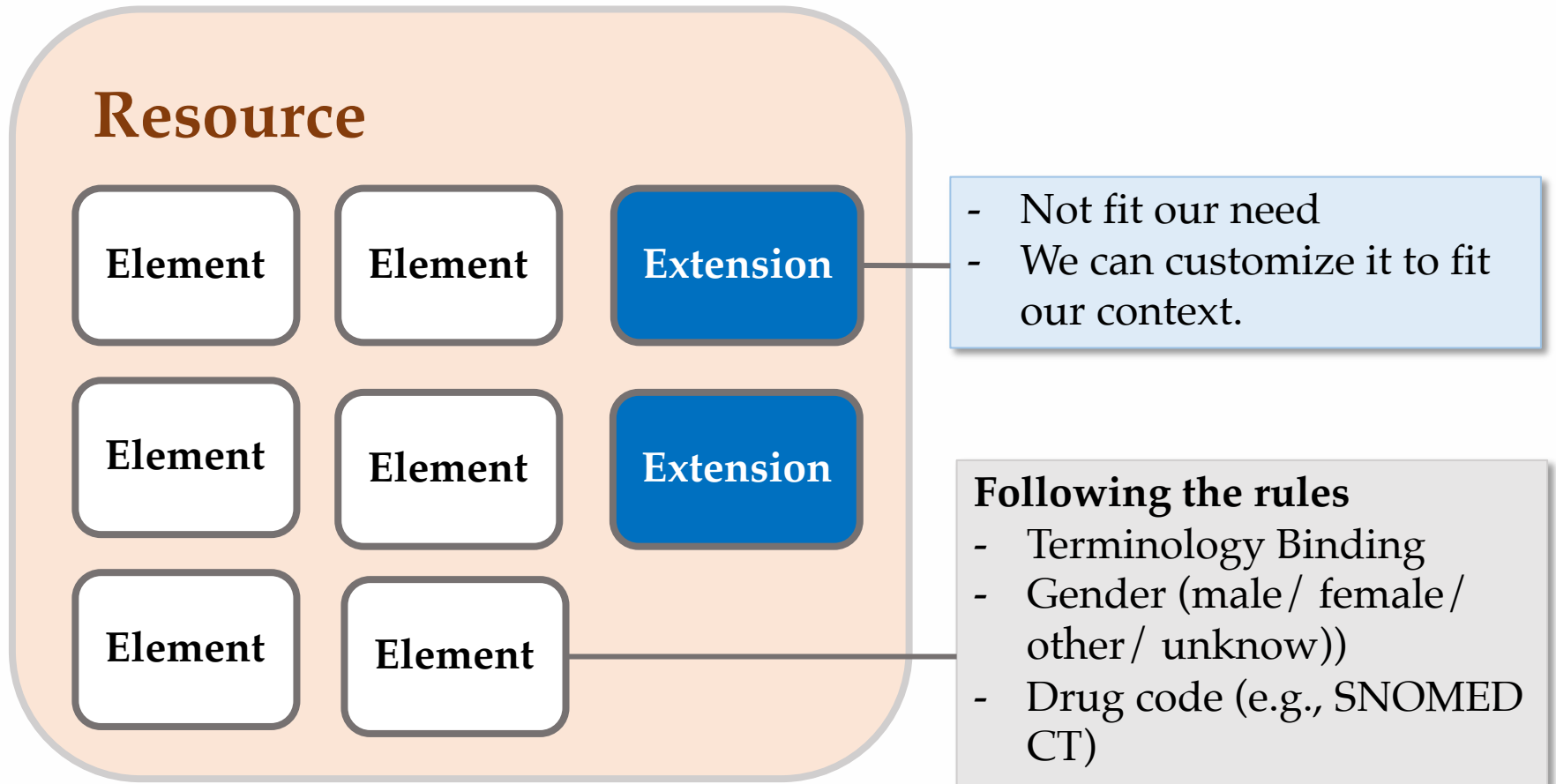
Example of medication resource (4)

11.5.3.1 Terminology Bindings

Path	ValueSet	Type	Documentation
Medication.code	SNOMEDCTMedicationCodes	Example	This value set includes all drug or medicament substance codes and all pharmaceutical/biologic products from SNOMED CT - provided as an exemplar value set.
Medication.status	MedicationStatusCodes	Required	Medication Status Codes
Medication.doseForm	SNOMEDCTFormCodes	Example	This value set includes all dose form codes from SNOMED CT - provided as an exemplar.
Medication.ingredient.item	SNOMEDCTMedicationCodes	Example	This value set includes all drug or medicament substance codes and all pharmaceutical/biologic products from SNOMED CT - provided as an exemplar value set.
Medication.ingredient.strength[x]	MedicationIngredientStrengthCodes	Preferred	Medication Ingredient Strength Codes

Example of patient resource (1)

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

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 Binding: 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 Binding: Marital Status Codes (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	C	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 Binding: Patient Contact Relationship (Extensible)
name	C	0..1	HumanName	A name associated with the contact person
telecom	C	0..*	ContactPoint	A contact detail for the person
address	C	0..1	Address	Address for the contact person
gender		0..1	code	male | female | other | unknown

Example of patient resource (2)

8.1.3.1 Terminology Bindings

Path	ValueSet	Type	Documentation
Patient.gender	AdministrativeGender	Required	The gender of a person used for administrative purposes.
Patient.maritalStatus	MaritalStatusCodes	Extensible	This value set defines the set of codes that can be used to indicate the marital status of a person.
Patient.contact.relationship	PatientContactRelationship	Extensible	The nature of the relationship between the patient and the contact person.
Patient.contact.gender	AdministrativeGender	Required	The gender of a person used for administrative purposes.
Patient.communication.language	AllLanguages (a valid code from Tags for the Identification of Languages ⬈)	Required	This value set includes all possible codes from BCP-47 (see http://tools.ietf.org/html/bcp47)
	Common Languages	starter	
Patient.link.type	LinkType	Required	The type of link between this Patient resource and another Patient/RelatedPerson resource.

Example of creating FHIR® resources (1)

- Mr. Somchai Jaidee, born April 3, 1967, Thai national ID 8-4027-26620-53-3

- He has an OPD visit on June 1, 2021, at Vejaree hospital. The hospital is located at 234 Phaholyothin Rd., Phaya Thai, Bangkok, 10400. He got a Hospital Number (HN) 64-52323 and a Visit Number (VN) 123

- He was taken care of by a check-up clinic from 9:00am to 12:00pm. The doctor who provided the service was Dr. Somsak Jingjai.

Credit: Dr. Rath Panyowat

Example of creating FHIR® resources (2)

name   dob   id-number

- Mr. Somchai Jaidee, born April 3, 1967, Thai national ID 8-4027-26620-53-3

    service-type   date   hospital

- He has an OPD visit on June 1, 2021, at Vejaree hospital. The hospital is located at
                        hos-address
    234 Phaholyothin Rd., Phaya Thai, Bangkok, 10400. He got a Hospital Number
            hn   vn
    (HN) 64-52323 and a Visit Number (VN) 123

                        clinic   start   end

- He was taken care of by a check-up clinic from 9:00am to 12:00pm. The doctor
                                    doctor
    who provided the service was Dr. Somsak Jingjai.

Credit: Dr. Rath Panyowat

Example of creating FHIR® resources (3)

Field name	FHIR	Value
name		Mr. Somchai Jaidee
dob		1967-04-03
id-number		8-4027-26620-53-3
service-type		OPD visit
date		June 1, 2021
hospital		Vejaree hospital
hos-address		234 Phaholyothin Rd., Phaya Thai, Bangkok, 10400
hn		64-52323
vn		123
clinic		check-up clinic
start		9:00
end		12:00
doctor		Dr. Somsak Jingjai

Credit: Dr. Rath Panyowat

Example of creating FHIR® resources (4)

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

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 Binding: 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 Binding: Marital Status Codes (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	C	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 Binding: Patient Contact Relationship (Extensible)
name	C	0..1	HumanName	A name associated with the contact person
telecom	C	0..*	ContactPoint	A contact detail for the person
address	C	0..1	Address	Address for the contact person
gender		0..1	code	male | female | other | unknown

Credit: Dr. Rath Panyowat

Example of creating FHIR® resources (5)

Field name	FHIR	Value
name	Patient.name	Mr. Somchai Jaidee
dob	Patient.birthDate	1967-04-03
id-number	Patient.identifier	8-4027-26620-53-3
service-type	Encounter.class	OPD visit
date	Encounter.period	June 1, 2021
hospital	Organization.name	Vejaree hospital
hos-address	Organization.address	234 Phaholyothin Rd., Phaya Thai, Bangkok, 10400
hn	Patient.identifier	64-52323
vn	Encounter.identifier	123
clinic	Encounter.serviceProvider or Encounter.serviceType	check-up clinic
start	Encounter.period.start	9:00
end	Encounter.period.end	12:00
doctor	Practitioner.name	Dr. Somsak Jingjai

Credit: Dr. Rath Panyowat

Example of creating FHIR® resources (6)

```json
{
  "resourceType": "Patient",
  "id": "example",
  "text": {
    "status": "generated",
    "div": "<div xmlns=\"http://www.w3.org/1999/xhtml\">\n\t\t\t<table>\n\t\t\t\t<tbody>\
  },
  "identifier": [
    {
      "use": "usual",
      "type": {
        "coding": [
          {
            "system": "http://terminology.hl7.org/CodeSystem/v2-0203",
            "code": "MR"
          }
        ]
      },
      "system": "urn:oid:1.2.36.146.595.217.0.1",
      "value": "12345",
      "period": {
        "start": "2001-05-06"
      },
      "assigner": {
        "display": "Acme Healthcare"
      }
    }
  ],
```

Format
- JSON
- XML

Credit: Dr. Rath Panyowat

Other functions

- Searching

```
GET [base]/Observation?_id=101
```

```
GET [base]/Observation?patient.identifier=http://example.com/fhir/mrn|1234
```

```
GET [base]/Observation?code=loinc|1234-1
```

```
GET [base]/Condition?onset=le1995
```

```
GET [base]/Condition?onset:text=1995
```

```
GET [base]/Condition?onset=23%20May%202009
```

```
GET [base]/Condition?myInvalidParameter=true
```

npj | Digital Medicine

ARTICLE   OPEN

Scalable and accurate deep learning with electronic health records

Alvin Rajkomar [1,2], Eyal Oren[1], Kai Chen[1], Andrew M. Dai[1], Nissan Hajaj[1], Michaela Hardt[1], Peter J. Liu[1], Xiaobing Liu[1], Jake Marcus[1], Mimi Sun[1], Patrik Sundberg[1], Hector Yee[1], Kun Zhang[1], Yi Zhang[1], Gerardo Flores[1], Gavin E. Duggan[1], Jamie Irvine[1], Quoc Le[1], Kurt Litsch[1], Alexander Mossin[1], Justin Tansuwan[1], De Wang[1], James Wexler[1], Jimbo Wilson[1], Dana Ludwig[2], Samuel L. Volchenboum[3], Katherine Chou[1], Michael Pearson[1], Srinivasan Madabushi[1], Nigam H. Shah[4], Atul J. Butte[2], Michael D. Howell[1], Claire Cui[1], Greg S. Corrado[1] and Jeffrey Dean[1]

Contribution

First, we report a generic <u>data processing pipeline</u> that can take <u>raw EHR data as input</u>, and <u>produce **FHIR**</u> outputs without manual feature harmonization. This makes it relatively easy to deploy our system to a new hospital.

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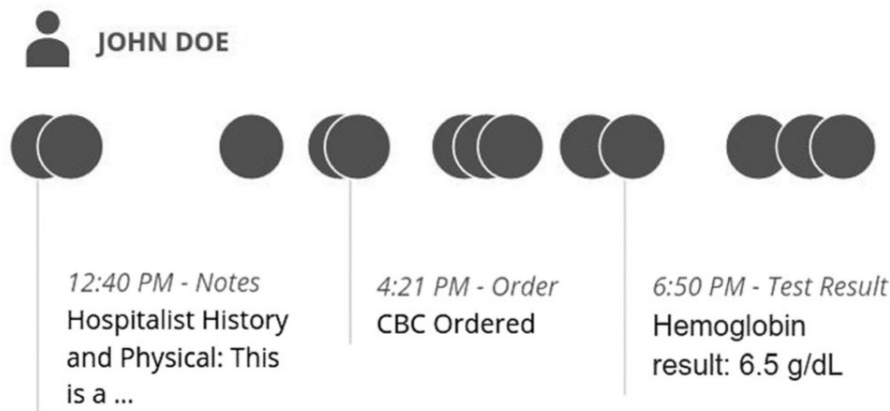Department of Clinical Epidemiology and Biostatistics

Datasets

- Included EHR data both <u>inpatient and outpatient</u> from 2 hospitals

- **Hospital A**; The University of California, San Francisco (UCSF) from 2012 to 2016

- **Hospital B**; The University of Chicago Medicine (UCM) from 2009 to 2016

Hospital	Data		
	Structure		Unstructure
A	- Patient demographics - Provider orders - Diagnoses - Procedures - Medications - Laboratory values	- Vital signs - Flowsheet data, which represent all other structured data elements (e.g., nursing flowsheets)	
B			- Free-text medical notes

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Rajkomar A, et al. NPJ Digit Med. 2018;1:18.

Data representation and processing

- The study developed <u>a single data structure</u> that could be used for all predictions, rather than requiring custom, <u>hand-created datasets for every new prediction</u>.

- This approach represents the entire EHR in temporal order: data are organized by patient and by time. To represent events in a patient's timeline, the author adopted the <u>FHIR standard</u>.

JOHN DOE

12:40 PM - Notes
Hospitalist History
and Physical: This
is a …

4:21 PM - Order
CBC Ordered

6:50 PM - Test Result
Hemoglobin
result: 6.5 g/dL

2

All available data for each patient is converted to events recorded in containers based on the Fast Healthcare Interoperability Resource (FHIR) specification.

Rajkomar A, et al. NPJ Digit Med. 2018;1:18.

Data representation and processing (1)

Data
- Patient demographics
- Provider orders
- Diagnoses
- Procedures
- Medications
- Laboratory values
- Vital signs
- Flowsheet data, which represent all other structured data elements (e.g., nursing flowsheets)
- Free-text medical notes

Manual mapping →

FHIR
Resources
- Patient
- Encounter
- Medication
- Observation (e.g. vital signs and nursing documentation)
- Composition (e.g. notes)
- Conditions (i.e. diagnoses)
- MedicationAdministration
- MedicationOrder
- ProcedureRequest
- Procedure
- Extension framework

Rajkomar A, et al. NPJ Digit Med. 2018;1:18.

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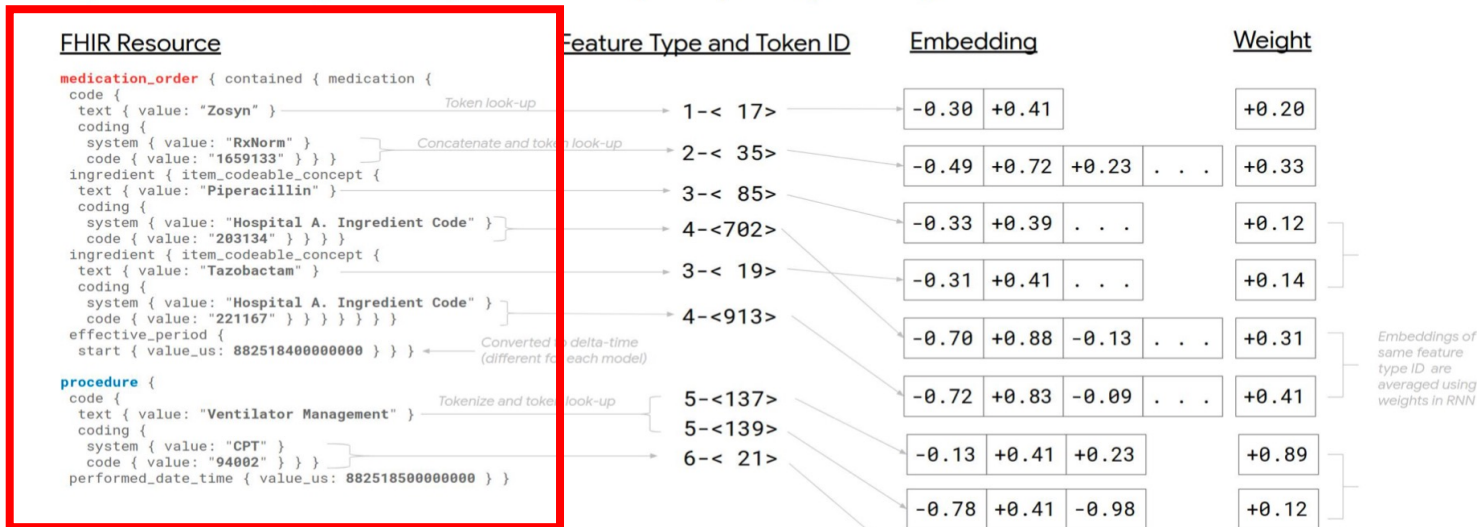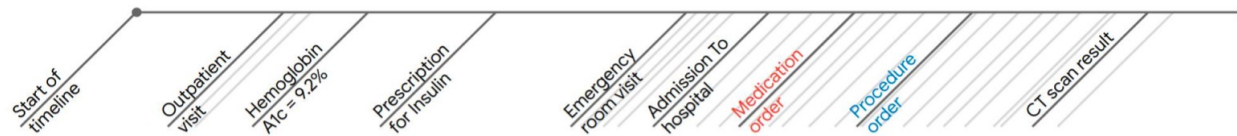# Data representation and processing (2)
Manual mapping

- Tables and fields <u>map directly</u> to existing resource types and attributes in FHIR.

- To incorporate EHR data that did <u>not map straightforwardly</u> to an existing FHIR resource type or attribute, <u>FHIR extensions</u> were used.

- The data did not harmonize elements to a standard terminology or ontology

- The only exceptions were for <u>diagnoses/procedures</u>, which we mapped to ICD9/10 and CCS categories if the health system did not already include them (e.g. for CPT codes), and for elements that were used to define the primary outcomes.
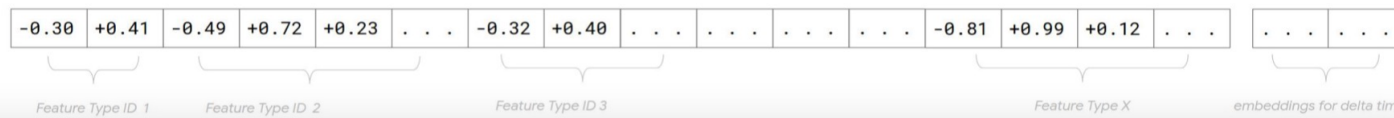
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Data representation and processing (3)

Data representation and processing (4)

FHIR Resource

```
medication_order { contained { medication {
  code {
    text { value: "Zosyn" }                    Token lo
    coding {
      system { value: "RxNorm" }
      code { value: "1659133" } } }             Concatenate
  ingredient { item_codeable_concept {
    text { value: "Piperacillin" }
    coding {
      system { value: "Hospital A. Ingredient Code" }
      code { value: "203134" } } } }
  ingredient { item_codeable_concept {
    text { value: "Tazobactam" }
    coding {
      system { value: "Hospital A. Ingredient Code" }
      code { value: "221167" } } } } } } }
  effective_period {
    start { value_us: 882518400000000 } } }       Co
                                                   (di

procedure {
  code {
    text { value: "Ventilator Management" }       Tokenize
    coding {
      system { value: "CPT" }
      code { value: "94002" } } }
  performed_date_time { value_us: 882518500000000 }
```

Structure

Name	Flags	Card.	Type
Medication	TU		DomainResource
identifier	Σ	0..*	Identifier
code	Σ	0..1	CodeableConcept
status	?! Σ	0..1	code
marketingAuthorizationHolder	Σ	0..1	Reference(Organization)
doseForm		0..1	CodeableConcept
totalVolume	Σ	0..1	Quantity
ingredient		0..*	BackboneElement
item		1..1	CodeableReference(Substance | Medication)
isActive		0..1	boolean
strength[x]		0..1	
strengthRatio			Ratio
strengthCodeableConcept			CodeableConcept
strengthQuantity			Quantity
batch		0..1	BackboneElement
lotNumber		0..1	string
expirationDate		0..1	dateTime
definition		0..1	Reference(MedicationKnowledge)

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Data representation and processing (5)

FHIR Resource

```
medication_order { contained { medication {
code {
  text { value: "Zosyn" }                    Token lo
  coding {
    system { value: "RxNorm" }
    code { value: "1659133" } } }             Concatenate
ingredient { item_codeable_concept {
  text { value: "Piperacillin" }
  coding {
    system { value: "Hospital A. Ingredient Code" }
    code { value: "203134" } } } }
ingredient { item_codeable_concept {
  text { value: "Tazobactam" }
  coding {
    system { value: "Hospital A. Ingredient Code" }
    code { value: "221167" } } } } } } } }
effective_period {
  start { value_us: 882518400000000 } } }      Co
                                                (di

procedure {
code {
  text { value: "Ventilator Management" }       Tokenize
  coding {
    system { value: "CPT" }
    code { value: "94002" } } }
performed_date_time { value_us: 882518500000000 }
```

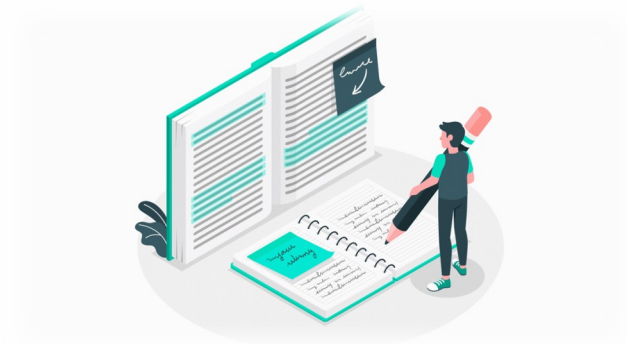| Name	Flags	Card.	Type
🔒 Procedure	TU		DomainResource
📦 identifier	Σ	0..*	Identifier
↗ instantiatesCanonical	Σ	0..*	canonical(PlanDefinition | ActivityDefinition | Measure | OperationDefinition | Questionnaire)
📒 instantiatesUri	Σ	0..*	uri
↗ basedOn	Σ	0..*	Reference(CarePlan | ServiceRequest)
↗ partOf	Σ	0..*	Reference(Procedure | Observation | MedicationAdministration)
📒 status	?! Σ	1..1	code
📦 statusReason	Σ	0..1	CodeableConcept
📦 category	Σ	0..*	CodeableConcept
📦 code	Σ	0..1	CodeableConcept

Wisdom of the Land

Summary

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Advantages of FHIR®

- 80/20 rule → the standard that will include only things widely used by 80% of systems in healthcare (minimum dataset).

- There is an extensibility framework to customize the standard to multiple contexts.

- Implementer friendly → It uses the same technology as other web applications. Who can develop a web app can develop a FHIR app.

- Large community → Easy to find tools. Easy to find help. Opportunity to connect with other countries that already implemented.

Credit: Dr. Rath Panyowat

Wisdom of the Land

1. Rajkomar A, Oren E, Chen K, Dai AM, Hajaj N, Hardt M, et al. Scalable and accurate deep learning with electronic health records. NPJ Digit Med. 2018;1:18

2. https://www.himss.org/himss-dictionary

3. FHIR: https://build.fhir.org/index.html