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Interoperability and Health Data Integration
Key Concepts

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Outline

- Interoperability 101
- The role of standards in interoperability
  - Clinical terminologies
  - Clinical information models
- Interoperability in action
  - Observational Health Data Sciences and Informatics (OHDSI)
  - University of California Health Data Warehouse

Interoperability of health data Definition

Interoperability is the ability of two or more systems to **exchange** health information and **use the information** once it is received.

Achieving Interoperability Depends on 5 Elements

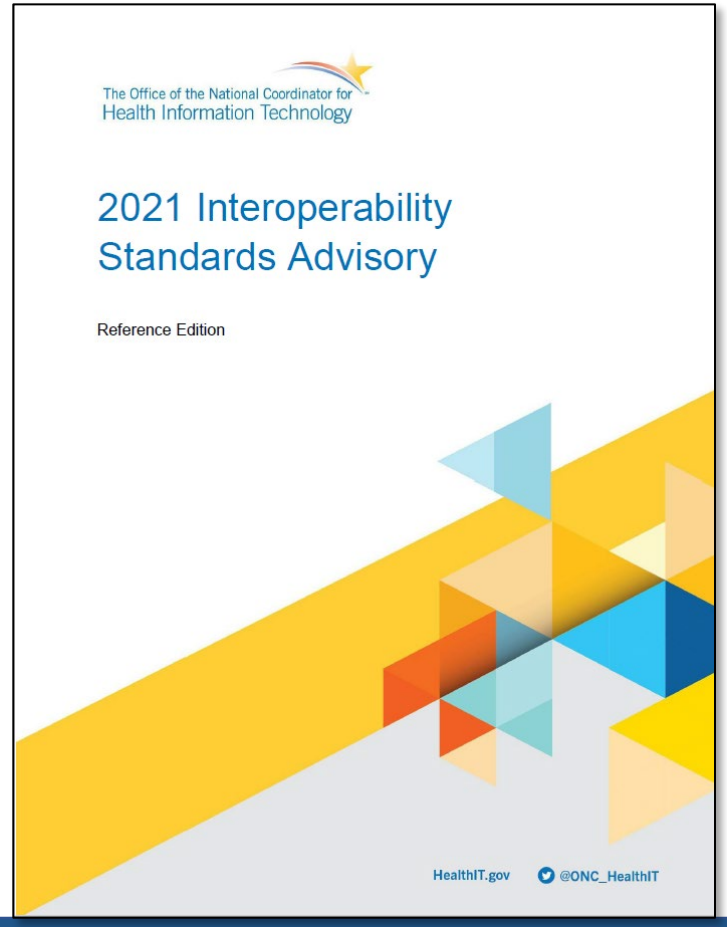
1) Adoption and Optimization
2) Standards
3) Financial and Clinical Incentives
4) Privacy and Security
5) Rules of Engagement

https://www.healthit.gov/sites/default/files/factsheets/onc_interoperabilityfactsheet.pdf

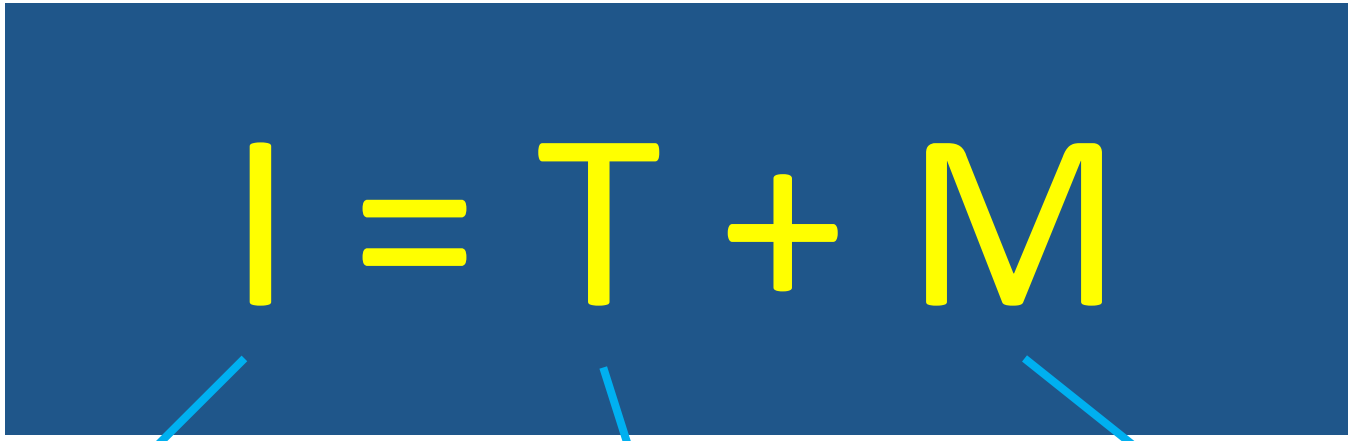
Interoperability of health data Reference

- “The Interoperability Standards Advisory (ISA) process represents the model by which the **Office of the National Coordinator for Health Information Technology** (ONC) will coordinate the identification, assessment, and determination of "recognized" **interoperability standards and implementation specifications** for industry use to fulfill specific clinical health IT interoperability needs.”

https://www.healthit.gov/isa/



Interoperability equation (Standards)



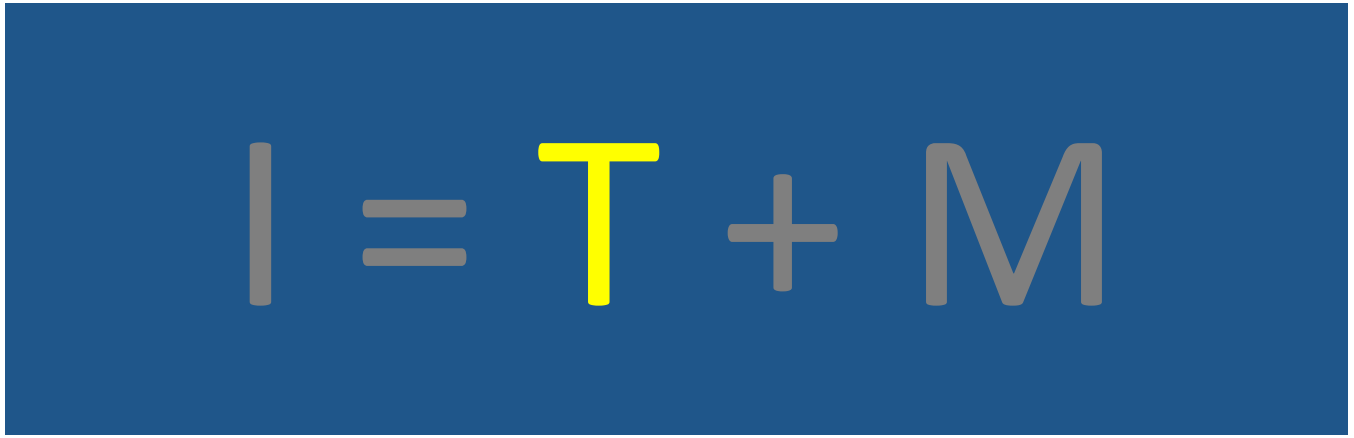
Interoperability

Terminologies

Information models

Vocabulary/Code Set/Terminology Standards

Content/Structure Standards


I = T + M

Main clinical terminologies (US)

I = T + M

- Main clinical terminologies for the Meaningful Use incentive program (clinical documentation; clinical quality measures)
  - SNOMED CT https://www.snomed.org/
  - LOINC https://loinc.org/
  - RxNorm https://www.nlm.nih.gov/research/umls/rxnorm/index.html
- Administrative terminologies (billing)
  - International Classification of Diseases – Clinical Modification (ICD10-CM)
  - Current Procedural Terminology (CPT)

Interoperability Need: Representing Patient Medical Encounter Diagnosis

Type	Standard / Implementation Specification	Standards Process Maturity	Implementation Maturity	Adoption Level	Federally required	Cost	Test Tool Availability
Standard	SNOMED CT®	Final	Production	●●●●○	Yes	Free	N/A
Standard	ICD-10-CM	Final	Production	●●●●○	Yes	Free	N/A

Interoperability Need: Representing Laboratory Tests

Type	Standard / Implementation Specification	Sta Ma	Level	Federally required	Cost	Test Tool Availability
Standard for observations	LOINC®	Fin		Yes	Free	N/A

FEDERAL REGISTER
The Daily Journal of the United States Government
Rule

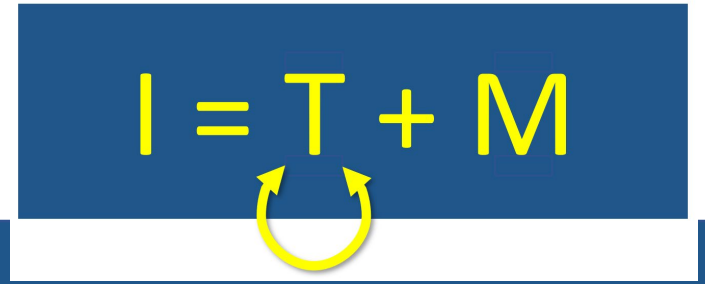
2015 Edition Health Information Technology (Health IT) Certification Criteria, 2015 Edition Base Electronic Health Record (EHR) Definition, and ONC Health IT Certification Program Modifications

Interoperability Need: Representing Patient Medications

Type	Standard / Implementation Specification	Standards Process Maturity	Implementation Maturity	Adoption Level	Federally required	Cost	Test Tool Availability
Standard	RxNorm	Final	Production	●●●●●	Yes	Free	N/A
Standard	National Drug Code (NDC)	Final	Production	●●●●●	Yes	Free	N/A

Interoperability among terminologies

- Pairwise mappings
  - Mapping between two terminologies
  - Example: SNOMED CT – ICD10 https://www.snomed.org/snomed-ct/Use-SNOMED-CT/maps
- Terminology integration
  - Mapping multiple, overlapping terminologies to a reference system
  - Example: Unified Medical Language System https://www.nlm.nih.gov/research/umls/index.html



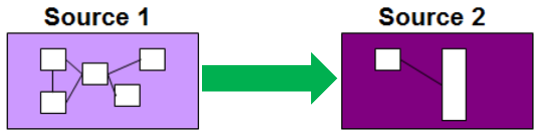

I = T + M

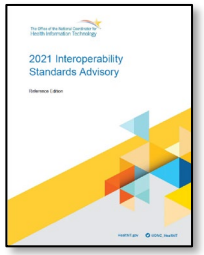
Main information models

I = T + M

Messaging standards

- To **exchange** clinical information electronically
- Examples
  - HL7 v2.x
  - HL7 Consolidated Clinical Document Architecture (C-CDA)
    - Care Plan, Consultation Note, Continuity of Care Document (CCD), Referral Note, Transfer Summary, …
  - HL7 Fast Healthcare Interoperability Resources (FHIR)

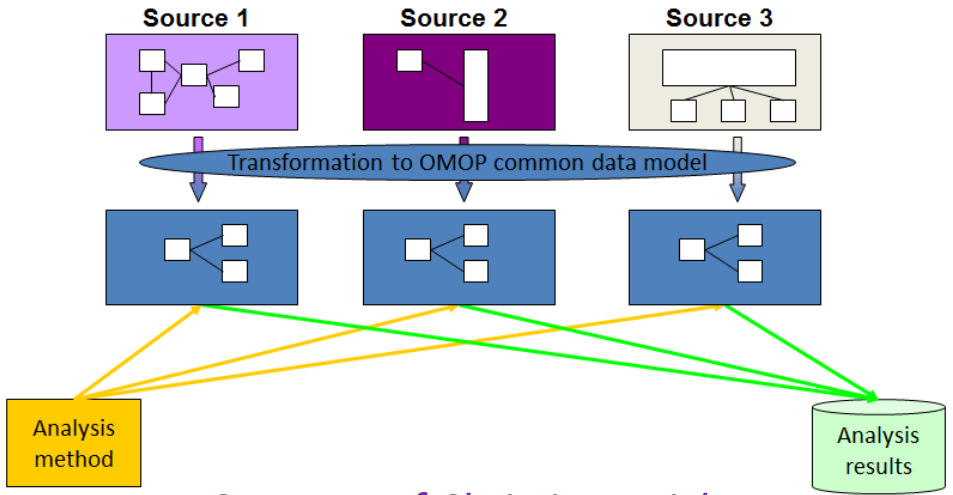




Clinical data warehouse standards

("Common Data Models")

- To **store and aggregate** clinical information



Courtesy of Christian Reich

Common data models

- OMOP [Observational Medical Outcomes Partnership]
  - Used in multiple clinical data warehousing/analytics initiatives (OHDSI, AllOfUs, UCHDW)

https://www.ohdsi.org/data-standardization/the-common-data-model/

- i2b2 [Informatics for integrating biology and the bedside]
  - Used in many translational research (and clinical analytics) projects

https://www.i2b2.org/

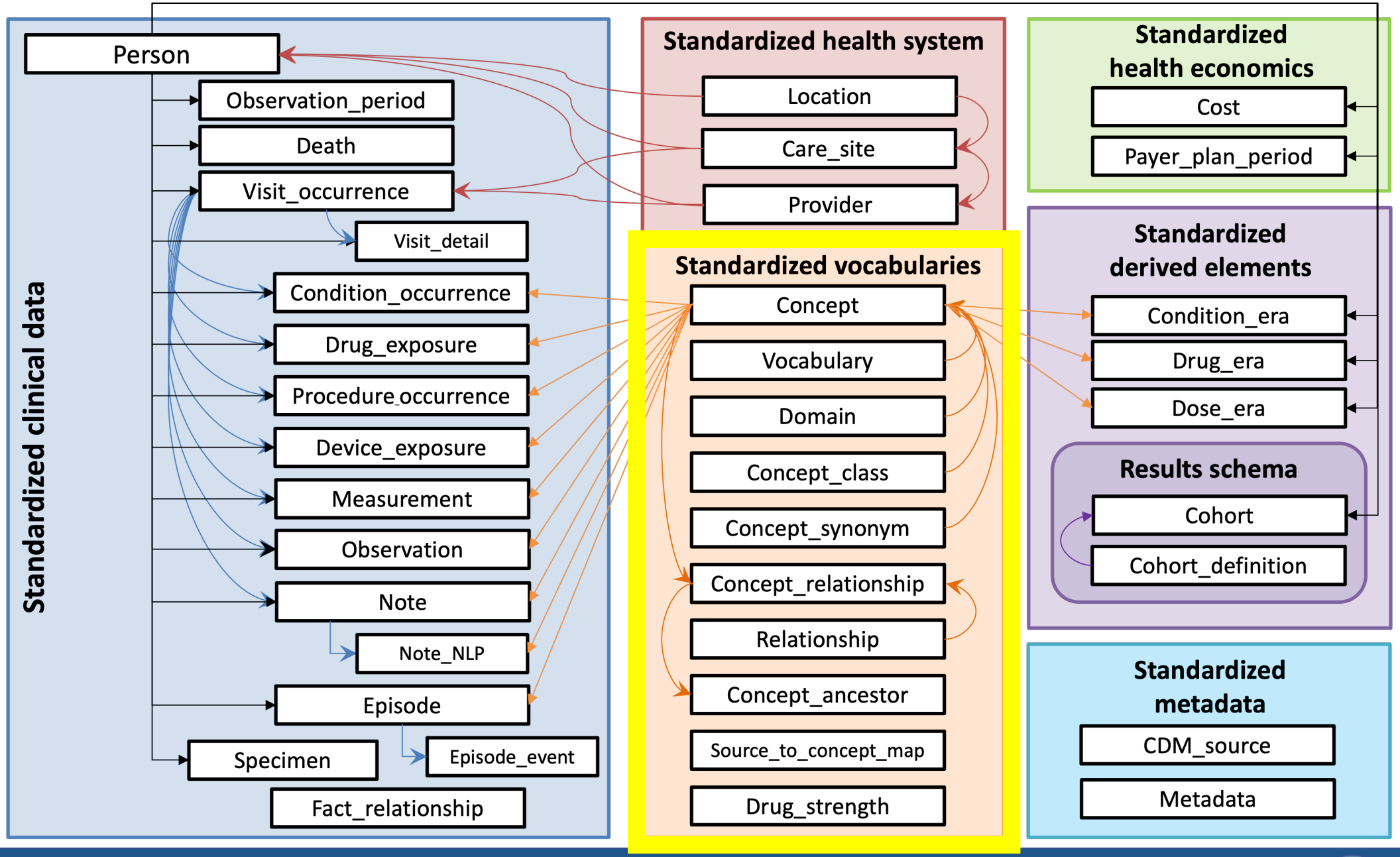
- PCORnet [National Patient-Centered Clinical Research Network]
  - Used for clinical research/pragmatic trial initiatives

https://pcornet.org/

- Sentinel [Food & Drug Administration]
  - Largest multisite distributed database in the world dedicated to medical product safety

https://www.fda.gov/safety/fdas-sentinel-initiative

OMOP


Standardized clinical data
Person
Observation_period
Death
Visit_occurrence
Visit_detail
Condition_occurrence
Drug_exposure
Procedure_occurrence
Device_exposure
Measurement
Observation
Note
Note_NLP
Episode
Episode_event
Specimen
Fact_relationship
Standardized health system
Location
Care_site
Provider
Standardized vocabularies
Concept
Vocabulary
Domain
Concept_class
Concept_synonym
Concept_relationship
Relationship
Concept_ancestor
Source_to_concept_map
Drug_strength
Standardized health economics
Cost
Payer_plan_period
Standardized derived elements
Condition_era
Drug_era
Dose_era
Results schema
Cohort
Cohort_definition
Standardized metadata
CDM_source
Metadata

Interoperability among information models

- Pairwise data element mappings
  - With FHIR: OMOP-on-FHIR, PCORnet-FHIR
  - Others: PCORnet-OMOP

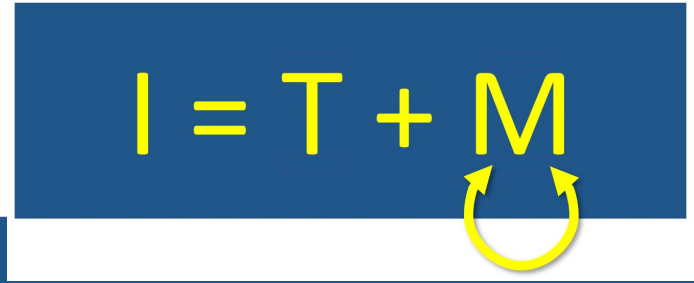
https://omoponfhir.org/

- Harmonization of common data models
  - PCORTF Common Data Model Harmonization Project

https://www.healthit.gov/topic/scientific-initiatives/pcor/common-data-model-harmonization-cdm

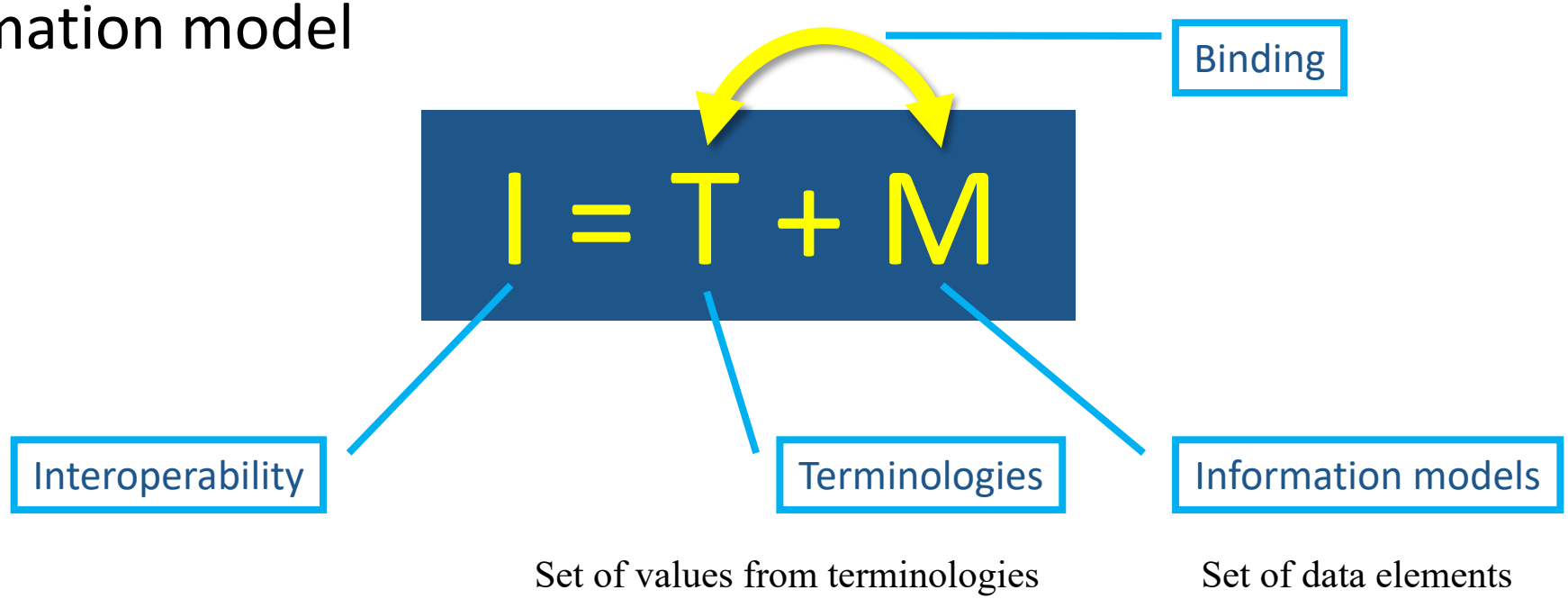
  - Example of use: National COVID Cohort Collaborative (N3C)

https://ncats.nih.gov/n3c



Binding between terminologies and information models

- Define the links between the information model and the terminology
- Constrain the set of possible values for a given data element in the information model




Inter-
operability
in action

Observational Health Data Sciences and Informatics (OHDSI)

Inter-operability in action

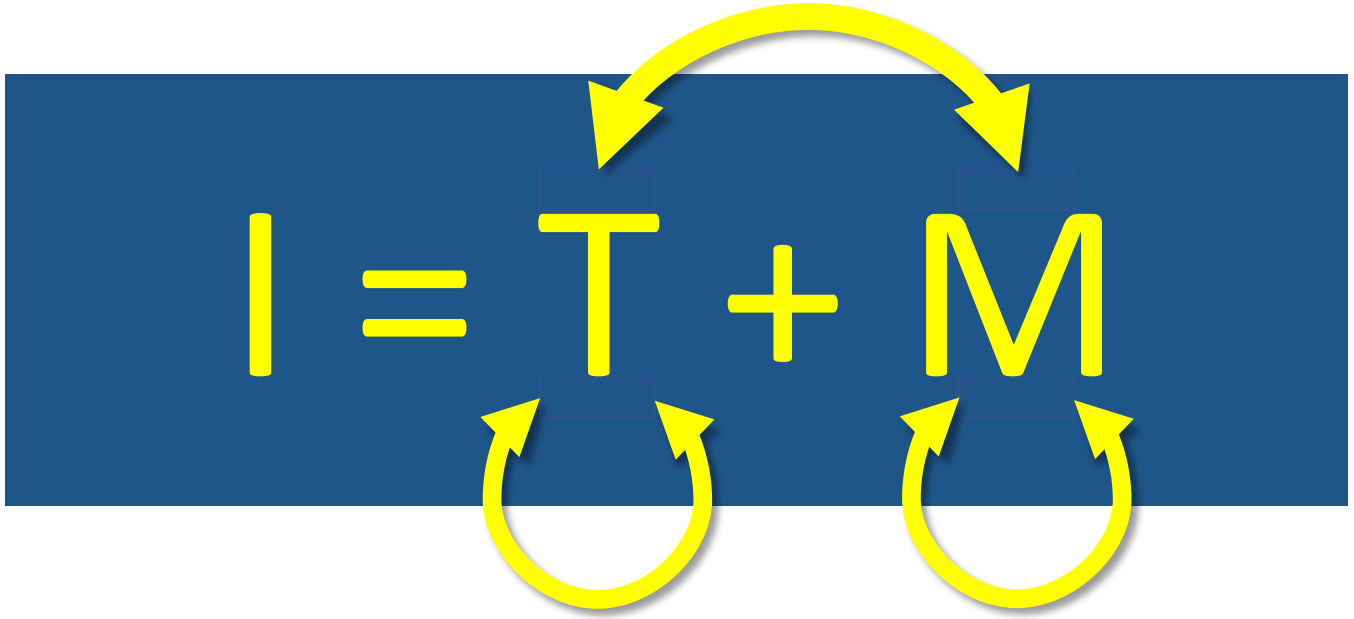
- International network of researchers and observational health databases
  - Large-scale clinical analytics
  - Standardized clinical data warehouses (OMOP)
  - Transparent methods and open-source tools
- Examples of outcomes – Application to COVID-19 analytics
  - Risk of hydroxychloroquine alone and in combination with azithromycin in the treatment of rheumatoid arthritis: a multinational, retrospective study (Lancet Rheumatol)
    - *Increased cardiovascular risk with azithromycin*
  - Comparative effectiveness of famotidine in hospitalized COVID-19 patients (Am J Gastro-Enterology)
    - *No evidence of a reduced risk of COVID-19 outcomes among hospitalized COVID-19 patients who used famotidine*
  - Renin-angiotensin system blockers and susceptibility to COVID-19: an international, open science, cohort analysis (Lancet Digit Health)
    - *No clinically significant increased risk of COVID-19 diagnosis or hospital admission-related outcomes associated with ACEI or ARB use was observed*

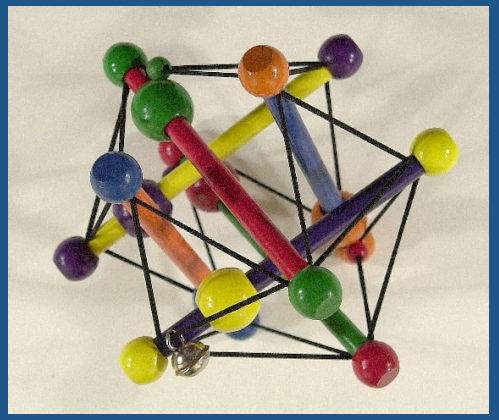
University of California Health Data Warehouse

Inter-operability in action

- Center for Data-driven Insights and Innovations
  - Business case for clinical data analytics
- University of California Health Data Warehouse
  - Data from 6 million patients since 2012
  - EHR data from six UC data centers
  - Claims data from UC's self-funded health plans
- Data integrated with OMOP CDM
- Applications
  - Population Health initiatives
  - Value-based Metrics
  - Pharmacy Initiatives (brand vs. generic drugs, system-wide trends for drugs prescribed)
  - Also supports research efforts

Summary Interoperability equation revisited





Medical Ontology Research

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