MACHINE LEARNING FOR HEALTH

Interoperability: The Rosetta Stone of Digital Health

How standards turn local records into shareable clinical intelligence

TECHNICAL HANDOUT · SESSION 03

Professor Flávio Luiz Seixas
Graduate Program in Computing

Academic teaching material based exclusively on the PDFs available in the project

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Introduction

Interoperability is the ability of systems to exchange data while preserving a useful interpretation. It is not limited to transporting bytes: it requires agreements on structures, identifiers, terminologies, context, and rules of use. [1]

This session examines the stack of agreements that connects syntax to semantics, compares terminologies, and shows why FHIR, SMART on FHIR, and OMOP address related but distinct problems. [1]

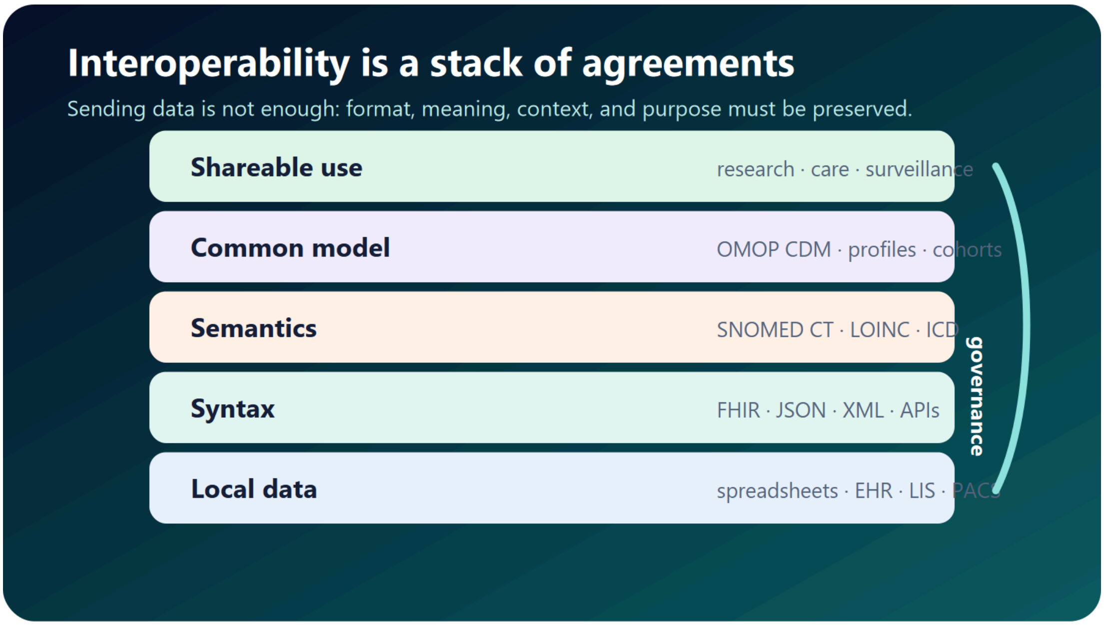

Figure 1 — Layers of interoperability. Source: original illustration based on the course material and [1]–[3].

1. Syntax, semantics, and context

Syntactic interoperability concerns the form of exchange; semantic interoperability concerns the preservation of meaning. Standards such as FHIR and DICOM support representation and transport, whereas SNOMED CT and LOINC provide concepts and codes. Both dimensions are necessary for data from different sources to be interpreted consistently [1].

Clinical models structure elements and bind code sets to the appropriate fields. This binding prevents an isolated code from losing information such as unit, method, specimen, time, and clinical context [2].

KEY CONCEPT
Syntactic interoperability concerns the form of exchange; semantic interoperability concerns the preservation of meaning.

2. Clinical terminologies

Classifications and terminologies serve different purposes. Classification systems aggregate cases into categories useful for statistics and administration; reference terminologies seek to represent clinical concepts with greater granularity and formal relationships. Correct use depends on the question and context [2].

LOINC represents observations through attributes such as component, property, time, system, scale, and method. SNOMED CT organizes concepts and relationships and supports more detailed compositions. Mappings between vocabularies are not purely mechanical: they require governance and analysis of information loss [2].

3. FHIR, applications, and analytical models

FHIR defines small, composable resources that can be serialized in formats such as XML or JSON and extended through profiles. A resource instance represents clinical or administrative information; sets of resources compose the context required for exchange [2].

SMART on FHIR allows applications to use standardized interfaces to access health-record data with authorization. The OMOP CDM, in turn, harmonizes data at rest for queries and analyses across institutions by connecting common tables to standardized vocabularies. FHIR favors exchange and operational integration; OMOP favors reproducible analysis over a common model [1].

4. Responsible interoperability

Standardization reduces integration work and allows questions to travel, but it does not correct source errors, selection, or definitions. Mapped data still depend on provenance, quality, and purpose. Governance must determine versions, profiles, value sets, and responsibilities for change [3].

Session summary

Syntax, semantics, and context: syntactic interoperability concerns the form of exchange; semantic interoperability concerns the preservation of meaning.
Clinical terminologies: classifications and terminologies serve different purposes.
FHIR, applications, and analytical models: fhir defines small, composable resources that can be serialized in formats such as xml or json and extended through profiles.
Responsible interoperability: standardization reduces integration work and allows questions to travel, but it does not correct source errors, selection, or definitions.

References

[1] Sim, I.; Sirota, M. Data and Computation: A Contemporary Landscape. In: Intelligent Systems in Medicine and Health. Springer, 2022. External link

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[2] Jaffe, C. et al. Standards in Biomedical Informatics. In: Biomedical Informatics. Springer, 2021. External link

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[3] Brixey, J. J.; Burningham, Z. Informatics-Related Standards and Standard Setting. In: Health Informatics. 2021.

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