

INFRA - Infection Radar - Shaping future approaches: A FAIR ontology as an interoperable hub for analysis, prediction, modeling, exchange, and visualization.*

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Abstract

INFRA (INFection Radar) is an SPHN-funded analytics and visualization platform that uses routinely collected EHR data to identify patients at risk of infection, while addressing semantic and syntactic heterogeneity that limits interoperable reuse. Using a tertiary-hospital clinical data warehouse integrating >40 source systems and >10 years of data, we implemented a dual-aligned semantic layer and data marts compliant with SPHN and OMOP CDM (OHDSI) and compatible with Epic Cosmos for two use cases: sepsis and post-surgical infections. Variables were harmonized and mapped to standard terminologies (SNOMED CT, LOINC, ICD-10, ATC, RxNorm; plus CHOP), enabling near-real-time SOFA computation, derived diagnoses, dashboards, and graph-based validation in Neo4j. Predictive models for postoperative infection risk were validated, demonstrating a scalable blueprint for interoperable infection surveillance and decision support, with ongoing expansion toward EHDEN-aligned federated research.

Keywords

OMOP Common Data Model, OHDSI, SPHN, Sepsis, SNOMED CT, graph, RDF, FAIR, Machine learning lifecycle

1. Introduction

Interoperable analytics in infection surveillance are compromised when hospital data originate from heterogeneous source systems, lack metadata, or use local code sets that do not map cleanly to international standards. The Swiss Personalized Health Network (SPHN) defines governance and semantic specifications for FAIR secondary use, while international federated research networks rely on Observational

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Medical Outcomes Partnership Common Data Model (OMOP CDM, OHDSI) and standardized vocabularies to enable reproducible phenotyping and cross-site studies.^{1–3} Sepsis exemplifies the challenge because operational definitions evolve over time (e.g., Sepsis-3 uses SOFA-based organ dysfunction), requiring granular representations of evidence and mappings.⁴

2. Methods

INFRA (INFection RAdar) was an SPHN-funded demonstrator (started March 2023) at Inselspital Bern with semantic collaboration from Geneva University and University Hospital and validation activities with the Lausanne University Hospital. We leveraged the Inselspital Clinical Data Warehouse (>40 systems; >10 years of legacy data) and implemented two use cases: (i) sepsis detection/organ-failure monitoring and (ii) postoperative infection risk prediction. A dual modeling strategy was applied: SPHN-aligned concepts for RDF export and parallel OMOP CDM representations to support OHDSI tooling and Epic transition readiness (legacy → Epic Clarity / Cosmos). Terminology alignment used standard terminologies (SNOMED CT, LOINC, ICD-10, ATC, RxNorm) and Swiss classifications (CHOP). Mapping and ETL documentation combined OHDSI tools (White Rabbit, Rabbit in a Hat, Usagi) with governed reference tables. For multilingual procedure descriptions, we applied an LLM-assisted translation and candidate mapping workflow (MAP-CARE) to generate English labels and import them into Usagi for similarity-based mapping, followed by expert validation.^{5,6} Neo4j/Bloom supported visual validation of mappings, provenance, and cross-terminology relationships.

3. Results

INFRA delivered an integrated semantic-to-analytics pipeline: (a) a sepsis / postoperative infection data mart exporting SPHN- and OMOP-conform concepts, (b) near-real-time SOFA computation and derived organ-complication phenotypes, and (c) clinician-facing SSRS reports and Apache Superset dashboards for operational monitoring. The pipeline aligned variables and code systems across pre-Epic and post-Epic sources, preserving longitudinal comparability during the March 2024 Epic migration. Mapping governance and graph-based validation improved traceability and reduced context-dependent, non-reusable mappings. On top of the governed semantic layer, explainable prediction models for postoperative infection were validated in surgical cohorts.⁷ At the ecosystem level, INFRA contributed to the establishment of the Swiss OHDSI National Node (hosted at Inselspital Bern) and served as a practical catalyst for the Bits-to-Breakthroughs conferences in Bern, which kicked off in 2023 with a sepsis focus.

4. Conclusion

INFRA shows that dual modeling to SPHN and OMOP CDM, anchored in standard terminologies and governed mappings, can support near-real-time sepsis / postoperative infection analytics and explainable risk prediction across heterogeneous hospital systems. The resulting blueprint—combining OHDSI tooling, LLM-assisted mapping, and graph-based validation—supports interoperability during HIS transitions (legacy → Epic) and positions Swiss sites for EHDEN-compatible federated research.

Declaration on Generative AI

During the preparation of this work, the authors used GPT-5.1 and DeepL for style, grammar, and spelling checks. After using these tools, the authors reviewed the complete content and edited the content as needed for corrections. The authors take full responsibility for the publication's content.

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