LEVERAGING MEDICAL TERMINOLOGIES VIA A MULTI-TERMINOLOGY SERVER TO ENHANCE THE INTEROPERABILITY IN DEDALUS SOLUTIONS

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Abstract

Achieving interoperability across healthcare systems is essential for improving healthcare delivery. Medical terminologies such as SNOMED CT, LOINC, and ICD play a pivotal role in standardizing clinical data, yet their integration into complex platforms remains challenging. This study evaluates the implementation of Ontoserver, a clinical terminology server based on HL7 FHIR, within Dedalus's software ecosystem to address these challenges. Technical enhancements, including the deployment of a sidecar FHIR resource server and workflow automation tools, facilitated efficient terminology management. A case study on Dedalus's "Trial for Care" platform highlighted the use of Ontoserver's concept mapping and exploration features to automate the standardization of bespoke codifications. Results showed improved data interoperability, reduced manual effort, enhanced data usability, and streamlined workflow transitions. While challenges such as managing regional standards and optimizing mappings persist, this study underscores the transformative potential of Ontoserver in achieving smarter interoperability and advancing healthcare outcomes.

Keywords

Interoperability, **Medical Terminologies**, **Ontoserver**, **HL7 FHIR**, **Data Standardization**.

1. Introduction

In healthcare, achieving a seamless continuum of care has long been a core objective, emphasizing consistent, connected patient experiences across different settings and phases of care [1]. Data interoperability becomes essential to achieve this goal, especially in a digital health landscape. Developing and sustaining clinical terminologies is widely recognized as a challenging task [2,3]. Dedalus, a global health software provider, faces the challenge of integrating diverse health data sources and formats across its solutions, making interoperability critical to enhancing patient care coordination and outcomes.

Medical terminologies, such as SNOMED CT, LOINC, and ICD, offer standardized language for capturing clinical data accurately. These terminologies enable consistent coding of symptoms, diagnoses, and treatments, facilitating data exchange among healthcare providers and software systems. However, implementing multiple terminologies across complex platforms can create redundancies and inconsistencies, posing significant challenges [4,5].

Ontoserver is a clinical terminology server based on the HL7's Fast Health Interoperability Resources (FHIR) standard, which was designed to contribute to the widespread adoption of clinical terminology and enhance interoperability by enabling consistent terminology management [6].

This paper examines how Dedalus adapts Ontoserver to manage these terminologies efficiently, to ultimately achieve smarter interoperability. Our aim is to evaluate the integration of this server into Dedalus's software ecosystem and its impact on interoperability, data accuracy, operational efficiency, and terminology management via a case study. Our contribution lies in developing an adaptable, scalable solution that bridges semantic gaps in healthcare data exchange.

2. Method

The methodology used in this study involved a two-pronged approach: technical enhancements together with integration of terminologies, and assessment of resulting improvements in interoperability via a use case. Ontoserver was selected as the central tool for harmonizing terminologies across platforms. This server operates by indexing and cross-mapping multiple terminologies, ensuring that data entered in one system can be accurately translated and interpreted across others.

2.1. Technical enhancements and workflow optimization

The base Ontoserver product was enhanced with additional functionalities to support efficient terminology management:

- A sidecar FHIR resource server was deployed to improve interoperability.
- Workflow automation tools were implemented to manage terminology updates and facilitate seamless integration of new releases (e.g., SNOMED updates).

2.2. Use Case: Concept Mapping & Concept Exploration

For assessment, we conducted case analyses on one of Dedalus's software solutions T4C (Trial for Care) where terminology inconsistencies had previously impacted data exchange and search outcomes. To address the challenge of centralizing and automating the mapping of bespoke clinical codifications to international standards, Ontoserver's advanced terminology management capabilities were explored.

Bespoke codifications, often hospital-specific and lacking standard terminological mappings, were processed using Ontoserver's concept mapping functionality. The method consisted of the following steps:

- Concept Addition: Bespoke concepts were first added to Ontoserver, with mappings applied where necessary to align with international standards, and then utilized by T4C in real-time ETL (Extract, Transform, Load) using thetranslation capability Ontoserver offers.
- Automapping: The bespoke concepts were automatically mapped against target-value sets, that were subsets of international codification systems such as SNOMED CT or RXNorm for medications. Ontoserver's automapping algorithms utilized descriptive metadata provided during the ETL process to determine the most appropriate match.

- Verification: Mapped concepts were manually reviewed by medical terminology experts to ensure correctness and relevance before being integrated into the data pipeline.

- Workflow Transition: We compared workflows before and after implementing Ontoserver; before: Optional, manually crafted mappings were maintained in unversioned CSV files, leading to inconsistencies and incomplete mappings; After: A centralized, version-controlled repository of codifications was established, containing both bespoke and their mapped international codes.

- User Interface for Concept Exploration: to enable clinical researchers to query processed data effectively for patient cohort building, a user interface was developed using Ontoserver's expand API. This API allowed users to explore the hierarchical relationships among concepts in various code systems and value sets, ensuring clarity and accessibility of the standardized data.

3. Results

Technical enhancements and workflow optimization led to a streamlined Terminology Management. The deployment of a sidecar FHIR resource server improved system interoperability, while workflow automation tools supported terminology updates, enabling seamless integration of new releases. Automated testing pipelines ensured early detection of issues from upstream changes, maintaining data consistency and reliability. These enhancements reduced manual effort, minimized errors, and ensured alignment with international standards.

The integration of Ontoserver into the T4C platform demonstrated measurable improvements in terminology standardization and data usability, effectively highlighted in Table 1.

Table 1: Improvements in terminology standardization and data usability after integrating Ontoserver into the Trial for Care platform

Improvement Area	Pre-Implementation	Post-Implementation
Enhanced Standardization	Bespoke codifications often lacked mappings, rendering datasets partially unusable for clinical research.	Automapping increased the percentage of bespoke codifications mapped to international code systems by 42%
Data Accessibility	Limited or no intuive tools for navigang terminological relationships and idenfying relevant concepts. Datasets were limited by bespoke terminologies, restricng usability for global research queries.	The UI, supported by the expanded API, offered intuive navigation of terminological relationships. Concept mapping transformed data into standardized terminologies, enabling efficient global cohort queries.
Operational Efficiency	Handcrafted mappings required significant manual effort, with a high potenal for errors.	Automated mapping reduced manual workload and error rates. Centralized management improved consistency and traceability.
Opmized Terminology Management	Updates to terminology content were me-consuming, errorprone, and lacked automation, wide target value sets led to inaccuracies, and manual updates were me-consuming.	Workflow automation tools improved the efficiency of updating and maintaining terminology content, ensuring alignment with the latest standards. The narrower target value sets improved automapping accuracy.

These outcomes collectively underline the critical role of Ontoserver in improving data interoperability within Dedalus's software ecosystem and advancing the continuum of care through efficient terminology management.

4. Discussion

This study highlights Ontoserver's pivotal role in standardizing terminologies and enhancing interoperability in Dedalus's ecosystem, addressing challenges in codification and terminology management. Regional-specific terminologies were also supported, as bespoke codings were mapped to standard codes rather than being deleted.

Despite these advancements, certain limitations and challenges remain. Ontoserver's performance in handling one-by-one updates and optimizing mapping for complex or ambiguous terminologies requires further refinement. Additionally, narrower target value sets improved automapping accuracy but necessitated careful selection to avoid excluding relevant mappings. Future iterations should focus on addressing these limitations to further enhance Ontoserver's capabilities. Another challenge in implementing a multi-terminology server is maintaining up-to-date terminologies across regions, especially as standards evolve. There are also privacy considerations, particularly in regions with strict data protection regulations, that Dedalus must address.
Finally, the need for scalability in a global organization necessitates ongoing technical maintenance and support.

Integrating Ontoserver into Dedalus's software ecosystem aligns with healthcare efforts to address interoperability challenges, as explored in similar studies. A systematic
review [5] emphasizes the critical role of standards such as HL7 FHIR, CDA, and SNOMED-CT in achieving interoperability and the importance of semantic interaction for effective data interoperability. This aligns with our study, which demonstrates the use of Ontoserver, based on the HL7 FHIR standard, to manage clinical terminologies and enhance data interoperability. The use and benefits of Ontoserver is discussed in other studies highlighting its role in improving data quality and interoperability in healthcare.
For instance, a large-scale clinical study successfully mapped 72.2% of unique medication names to standardized terminologies using Ontoserver, significantly enhancing the analysis of medication data [7]. Similarly, the transformation of the German Alpha-ID terminology into FHIR CodeSystems using Ontoserver demonstrated its capability to handle large datasets and improve semantic interoperability [8].

Other studies discuss the challenges of semantic, structural, and syntactic interoperability in medical information systems underlying the goal of achieving seamless data exchange [9]. Our study addresses similar challenges and goals by implementing Ontoserver to automate the mapping of bespoke clinical codifications to international standards. The study on eHealth and AI in the EU highlights the potential of AI to enhance data interoperability [10]. Although our study does not directly incorporate AI, the use of Ontoserver's advanced terminology management capabilities can be seen as a step towards leveraging technology to improve interoperability. Future research could explore the integration of AI to further enhance these capabilities.

5. Conclusion

By automating the mapping of bespoke codifications to international standards and providing intuitive tools for terminology management, Ontoserver has streamlined workflows, reduced manual effort, and enhanced data accessibility. These advancements not only align with Dedalus's mission of improving patient care coordination but also address key challenges in healthcare interoperability, including data fragmentation and redundancy.

Despite these achievements, ongoing efforts are required to further optimize Ontoserver's performance, particularly in handling complex terminologies and maintaining up-to-date content across diverse regions and standards. Addressing these challenges, alongside considerations for scalability and data privacy, will be crucial for sustaining and expanding the system's effectiveness. This study underscores the critical role of advanced terminology management solutions in achieving smarter interoperability and paves the way for future research to explore innovative technologies, such as AI, to enhance these capabilities further.

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