Expanding the OMOP Common Data Model to support Extracorporeal Life Support research

Clemens Rieder[1], Oleg Zhuk[2], Ahmed Said[3], Peta M.A. Alexander[4], Dominik J. Hoechter[1]

[1]Department of Anaesthesiology, LMU Klinikum, Ludwig-Maximilians-University, Munich, Germany
[2]Odysseus Data Services, an EPAM Company, Cambridge, MA, USA
[3]Pediatric Critical Care, Washington University in St. Louis, St. Louis, MO, USA
[4]Department of Cardiology, Boston Children's Hospital, and Department of Pediatrics, Harvard Medical School, Boston MA, USA

Background

Extracorporeal life support (ECLS) has been continually refined since its first successful use in the 1970s and is a keystone in today's critical care. Advancements in surgical techniques, redesigned technical systems(1), or new and improved materials(2) combined with increasingly complex cannulation strategies(3,4) have resulted in a manifold terminology, often used inconsistently by clinicians and researchers in scientific reports and publications. Intending to provide a consistent and unambiguous nomenclature for the future, the Extracorporeal Life Support Organization (ELSO), which has been collecting member centers' ECLS-specific data in a consistent format in the ELSO registry since 1989, resulting in over 200,000 patient records(5), published terminology guidelines in 2018 and 2019, the ELSO Maastricht Treaty(6,7).

Unfortunately, the OMOP Common Data Model (OMOP CDM), while using a multitude of well-established terminologies, lacks the capability to store ECLS-related data sufficiently due to a lack of fitting concepts as well as poor user operability in complex cases of ECLS. Thus, we developed a custom expansion to the OMOP CDM, called the *Extracorporeal Life Support Common Data Model* (ECLS CDM), and introduced fitting concepts as part of the OMOP Extension vocabulary to support the proficient capture of ECLS-related data.

Methods

The OMOP CDM standardized clinical tables (version 5.4) were analyzed for ease of use concerning data management of ECLS-related parameters without using any additional tables besides the tables present. Typical ECLS use cases, such as a change of the cannulation strategy, failure management as well as the simultaneous use of separate consoles or the exchange of components, were utilized for the analysis using a pen-and-paper strategy drawing out possible mapping solutions. Clinical terms defined in the ELSO Maastricht Treaty and the ELSO Data Definitions document (version 04/15/2024) were checked against equivalent concepts present in the OMOP Standardized Vocabularies using Athena, the SNOMED CT browser - International Edition and the LOINC browser. The ELSO Data Definitions Document contains a detailed explanation of every mandatory and non-mandatory parameter collected as part of the minimum dataset of the ELSO registry. By definition, concepts qualifying for consideration had to be valid, standard, and belong to one of the following domains: Condition, Drug, Device, Measurement, Observation, Procedure. Expansion database tables were designed for the PostgreSQL relational database management system following best practices.

Results

Analysis of the registry and the common data model showed that with the current database table layout and concepts present in the OMOP CDM, data derived from extracorporeal circuits could not be captured adequately. Out of 75 concepts of the ELSO Maastricht Treaty, 15 (20%) were directly

mappable to existing valid and standard concepts. Five concepts (7%) could be represented via postcoordination. For 55 (73%) concepts, no equivalent could be found without losing semantic information. For 28 (51%) of the 55 concepts without an equivalent, new concepts were designed, while 27 (49%) were excluded from the design process after requirement analysis.

Four hundred and seventy concepts present in the ELSO Data Definitions Document were analyzed. These did not include concepts deriving from the Current Procedural Terminology, version 4 (CPT-4) or the International Classification of Diseases, version 10 (ICD-10, including modifications) since they are already part of the OMOP CDM vocabulary set. Fifty-one new concepts (11%) were designed, while 419 (89%) could be disregarded during the design process due to already available concepts or equivalent table attributes within the OMOP CDM Standardized Vocabularies. In total, 142 new concepts were introduced.

Custom database tables specific to extracorporeal therapy were introduced and logically divided into core and support tables. Core tables share a direct link to the OMOP CDM standardized clinical data tables via a foreign key relationship to the person table. In contrast, support tables were linked solely to core tables and provide more detailed information about the components described in the core tables as well as connecting components via many-to-many relationships.

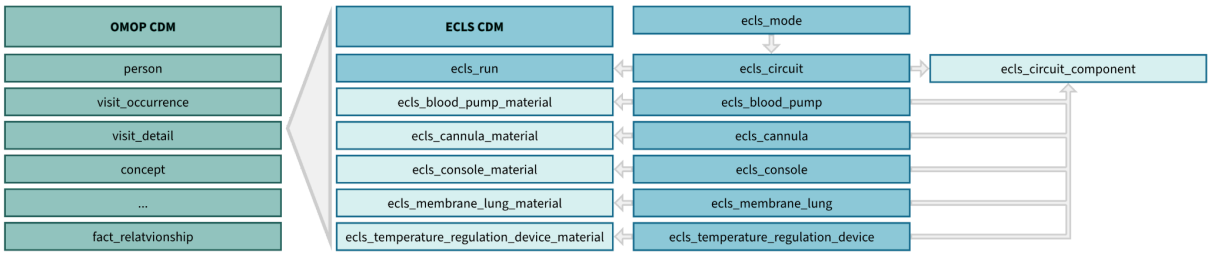

Figure 1. Structure of the ECLS CDM.

The expansion is released as an open-source project on GitHub and is available from the following address: https://github.com/ecls-cdm. The GitHub repository will also include ETL recommendations for the ELSO ECLS data registry.

Conclusion

We present the first iteration of the Extracorporeal Life Support Common Data Model (ECLS CDM), an open-source expansion to the Observational Medical Outcomes Partnership Common Data Model (OMOP CDM), specifically designed to enable the standardized capture and processing of data collected in the context of extracorporeal life support. We aim to continuously update and develop the model to fit the ECLS community's needs for a comprehensive, standardized solution to ECLS-related data management and regard our work as another step in the attempt to improve the overall quality of care and patient outcomes by facilitating quick and effective research in the future using a common data language stored in a unified data model.

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