

REDHot OMOP: Facilitating Semantic Interoperability in REDCap with FHIR and the OMOP CDM

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Background

Insufficient interoperable data exchange when conducting observational research.^{1,2} One of the leading clinical research informatics (CRI) tools for observational research is Research Electronic Data Capture (REDCap). As the REDCap community has expanded beyond Vanderbilt University to an international consortium of over 3,200 partners, addressing issues of data interoperability has gained considerable importance.³ The Observational Medical Outcomes Partnership (OMOP) Common Data Model (CDM) serves as a solution for organizations across the globe to conduct systematic analysis of disparate databases. Health Level Seven (HL7[®]) Fast Healthcare Interoperability Resources (FHIR[®]) has become a well-trusted standard for facilitating data-exchange at the electronic health record (EHR) level.⁴ There have been recent efforts to combine each of these three resources: REDCap and OMOP, at institutional levels²; REDCap and FHIR, through the consortium;^{5,6} and OMOP and FHIR, from Georgia Tech.⁷ Further, at the start of 2021, there was an announcement of an official partnership between HL7 and the OHDSI network, who maintains OMOP, to provide a Single CDM for sharing information in clinical care and observational research.⁸ To our knowledge, however, there is no prior work that leverages all three resources, REDCap, FHIR, and OMOP, into one system. An exemplary use case for such a system would be performing chart reviews to enhance existing data.

When a group conducts a chart review for retrospective analysis, information will be collected in electronic case report forms, such as REDCap forms.^{9,10} The various entities generating case report forms inevitably augment the data with some amount of clinical knowledge, whether that be the potential for an adverse event or more suitable diagnosis.^{11,12} Then, when researchers seek to review various sources of information for a retrospective observational research study, the main concerns are: “How do we get the information from the case reports into the data model?” and “How do we address a lack of standardization in the collection and processing the data collected in reports from disparate sources?” In response to those concerns, we are developing a new tool called *REDHot OMOP*, a Substitutable Medical Applications Reusable Technologies (SMART) on FHIR¹³ application, which will leverage the benefits of FHIR and OMOP to be the conduit of clinical data standardized in a format tailored toward improving translational and observational research endeavors.

Methods

Since REDCap operates on and can be expanded via open-source components, thanks to the REDCap Consortium³, it appeared reasonable to leverage existing resources^{6,7} as a foundation and fill in any remaining gaps with REDHot OMOP. Figure 1 describes the system architecture that connects with REDHot OMOP. REDHot OMOP exists as the conduit in a system that will allow researchers to leverage customizable, interoperable, as well as FHIR and OMOP compliant, REDCap form data.

The pipeline works as follows: **(1)** users enter information of any data type into a REDCap form **(1a)** with any free-text input being captured in a specialized field, augmented by REDCap’s Ontology Provider service. The Ontology Provider is linked to a local FHIR Terminology Service through an External Module developed by a team from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia. The FHIR Terminology Service **(1b)** returns a list of potential codes, based on a pre-defined list of values (FHIR ValueSet Resource) from local code system selected by the form designer in advance, from which the user can select the most appropriate choice. Once the form is complete, **(2)** the form report is exported via the REDCap application programming interface (API) into Redmatch, a CSIRO tool that transforms REDCap form reports with user-defined mapping rules. After the user loads the report and assigns appropriate values, **(3)** Redmatch converts the REDCap data into FHIR Resources and sends them to REDHot OMOP. The FHIR Resources with the local codes are stored in REDHot OMOP and the data associated with the

Resources are **(4a)** sent to OMOPonFHIR, a HL7 API (HAPI) FHIR server, which will make the information OMOP compliant. OMOPonFHIR **(4b)** maps the input codes to their OMOP equivalents using an internal translation service, stores the data in a local OMOP database, and returns all viable mappings to REDHot OMOP. Subsequently, REDHot OMOP **(5a)** provides the user with a representation of the REDCap data in both custom and all mappable OMOP codes for covariate analysis or visualization. As an additional route, REDHot OMOP can also **(5b)** connect with an EHR, if it is established in an institution, or external application via the SMART on FHIR platform. With the

Legend

- Middleware
- Front-end application
- Database
- Standard connection
- Connection requiring admin approval

Conclusion

References/Citations

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