Distributed Queries for Quality Control Checks in Clinical Trials

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1. Abstract

Operational Quality Control (QC) checks are standard practice in clinical trials and ensure ongoing compliance with the study protocol, standard operating procedures (SOPs) and Good Clinical Practice (GCP).

We present a method for defining QC checks as distributed queries over case report forms (CRF) and clinical research imaging data-sources. CRFs are stored in REDCap[1], an Electronic Data Capture (EDC) system, while imaging data is stored in XNAT[2], the eXtensible Neuroimaging Archive Toolkit, a research Picture Archiving and Communication System (PACS).

Our Query Manager[3] (QM) application provides a distributed query system that can integrate time-sensitive information in order to populate QC checks that can facilitate the process of data discrepancy resolution that takes place throughout the lifecycle of a clinical trial.

2. Introduction

QC checks are a standard part of the operational workflow of clinical trials that inform project managers (PMs) of protocol, SOP, and GCP violations.

They help ensure timely identification and resolution of violations, which can include data discrepancies, inclusion/exclusion criteria errors, adverse events, etc.

The problem is that the information needed to identify some QC issues is stored in multiple locations (e.g., EDC, PACS). This situation leaves researchers lacking real-time, integrated access to the information that is needed for time-sensitive and proactive data management.

Researchers who identify QC issues in real-time will save time and money by correcting errors that would otherwise lead to lost data and inefficient reconciliation processes.

As part of multisite clinical trial planning grant, we developed an approach to address the issue of time-sensitive QC checks by integrating information stored in XNAT about MRI exam quality with CRF data stored in REDCap.

The clinical trial protocol requires that MRI exams are acquired within seven days of a clinical visit. We anticipate most clinical and MRI exams to occur on the same day; however, in some MRI exams we expect to find artifacts, such as movement, that will require a rescan.

Here we will describe our approach to this use-case by following the evaluation of a distributed query through our QM Application. We expect that this approach will be useful for a wide variety of QC checks for clinical trials.

3. Methods

The QM provides a graphical user interface that enables users to compose, edit, evaluate, save, share, and discover queries, including distributed QC checks. (Figure 1-1)

QC checks are specified by a researcher or PM and implemented by a user proficient in the Distributed Xquery (DXQuery) language. A user submits a DXQuery to the QM server (Figure 1-2) which generates a unique identifier for the query and then stores the query and metadata in the QM database (Figure 1-3).

A saved QC check is executed from either the QM web interface or the associated Query Execution Service (QES). Queries executed from the web interface are directed by the QM Server to the appropriate Query Service (e.g. DXQuery, SPARQL, VSPARQL, IML, etc.), where the query is then evaluated and shipped out to the appropriate data-source(s) (Figure 1-4).

The QES provides a RESTful interface for evaluating QM queries based on the unique identifiers assigned to saved queries by the QM Server. Queries executed by the QES are processed in the same way as above, but when the URL is resolved only the raw XML document is returned (Figure 1-5).

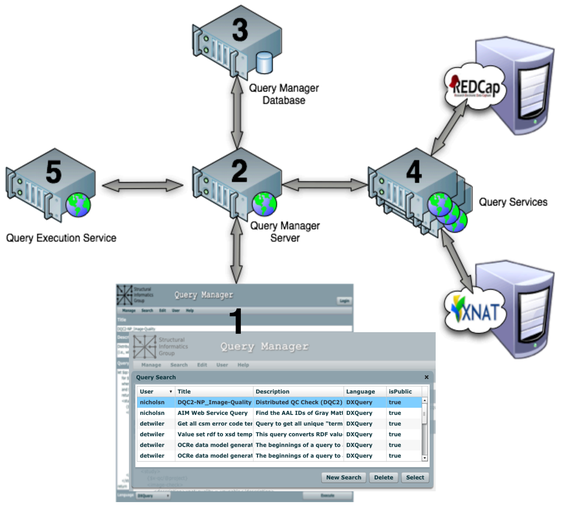

Figure 1. Query Manager Architecture

4. Results

Our results are demonstrated by an example query that integrates two data-sources. The XNAT database provides, via REST, visit-level subject data, including the subject ID, exam date, and an evaluation of MRI quality (Figure 2). Similarly, REDCap provides visit-level clinical data, including a key that links to XNAT (Figure 3).

The query matches visit-level subject data based on the subject ID, and if the image quality is 'unusable' the query then compares the clinical exam date returned by REDCap to the current date and calculates the number of days left to acquire a 'good' quality exam (Figure 4).

An XML summary of the results is returned that informs the user about the number of days left to perform an action item (i.e., rescan the subject) and remain in the window to be comparable to the clinical visit data, which is defined by the trial protocol (Figure 5).

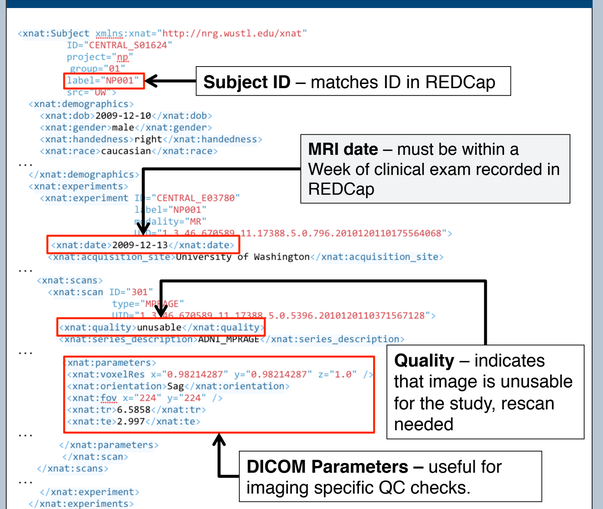

Figure 2. Participant record from XNAT

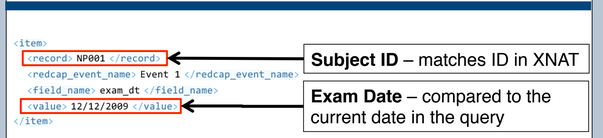

Figure 3. Participant record from REDCap

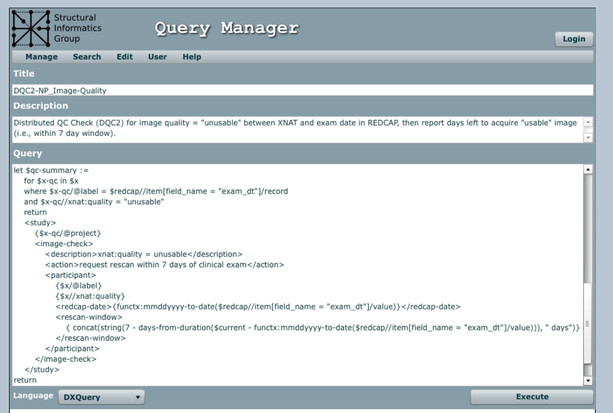

Figure 4. Example query code

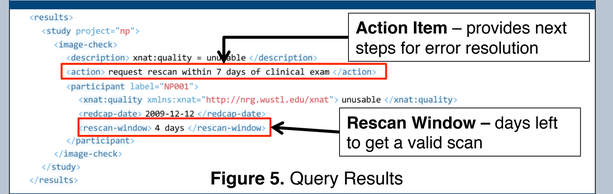

Figure 5. Query Results

5. Conclusion

The QM supports the definition of QC checks as distributed queries over multiple data-sources that return XML.

The QES provides a RESTful interface for evaluating such definitions and provides resolvable unique identifiers (URIs) for the results (potentially usable for QC check report generation).

Such queries can be issued in against REDCap and XNAT data-sources, providing real-time information about distributed QC check status.

6. References

1. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap). J Biomedical Informatics. 2009; 42:377-381.
2. Marcus DS, Olsen TR, Ramaratnam M, Buckner RL. The extensible neuroimaging archive toolkit. Neuroinformatics 2007; 5:11-33.
3. Detwiler LT, Shaw M, Brinkley JF. Ontology View Query Management. Proceedings from AMIA Symposium 2010.

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