Cancer Reporting from Laboratory Information Systems to State Cancer Registries

CS 6440 Health Informatics

Team FHIR MDT

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Problem Statement

The laboratories that are responsible for cancer diagnostic tests and reporting are required to electronically transmit data to the State Cancer Registries. The College of American Pathologists (CAP) have created electronic cancer checklists (eCCs) templates to support electronic management and distribution of Cancer related laboratory tests.

The cancer data is collected traditionally from pathology laboratories. The lack of standardized system to report the laboratory results to central Cancer Registry can result in varying reporting procedures. This can also lead to the problem of having incomplete data collection and missing statistics for future research and diagnostic purposes. Our project focused on helping address some of the issues.

The goals of this project include the following:

1) Complete, correct, and verify compliance of sample cancer questionnaires with the Fast Healthcare Interoperability Resources (FHIR) HL7 standard.
2) Create Extensible Stylesheet Language Transformation (XSLT) data to produce Hyper Text Markup Language (HTML) forms for each FHIR HL7 Questionnaire to allow the technicians to complete the form data.
3) Generate FHIR HL7 compliant Questionnaire/Response XML results from the completed HTML forms that could be transmitted to a State Cancer Registry system.

Background

Laboratories report cancer information by filling out specific forms. Certain indicators in those forms mean that a case is reportable and the technician should submit the report to the State Cancer Registry. The medical industry, through facilitation by the federal government, is moving to the Stage 3 of Meaningful Use for Electronic Health Records. Stage 1 of meaningful use focused on capturing patient data electronically and reporting on the data. Stage 2 focused on health information exchanges and the electronic transmission of patient data. Stage 3 is focused on decision support for high priority conditions and access to patient data using a standard system such as the FHIR standard. FHIR is the standard that it currently being promoted for this initiative.

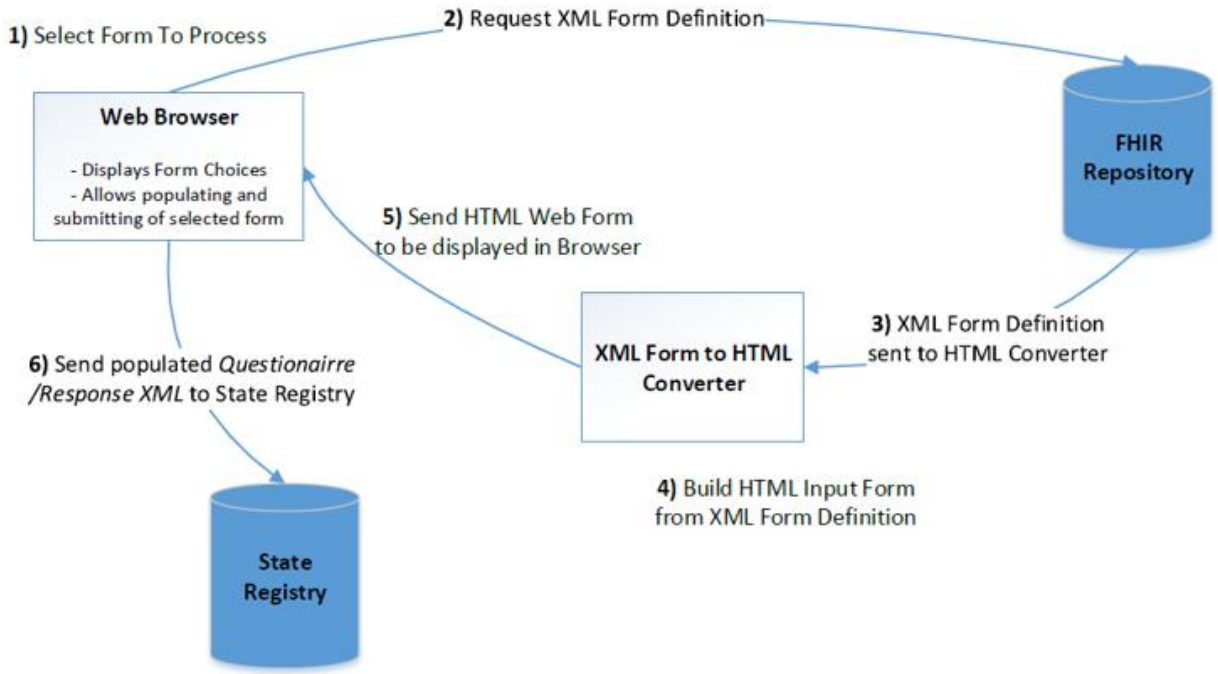
Research

Our team consists of diverse professionals within the Information Technology industry with some experience with the Healthcare initiatives. Working with our mentors from the Center for Disease Control (CDC), Sandy Jones and Paula Braun, we solidified our understanding of the goals intended to move the electronic reporting initiatives to compliance with the FHIR HL7 standard. Our mentors were able to provide us with contextual background on the specific challenges to be addressed by our project and sample documentation and source material. Through ongoing discussions, we confirmed a specific workflow and technical design to support the project goals. We referenced the http://www. hl7.org web site related to the specific Questionnaire and Questionnaire/Response XML standards. We focused on two specific cancer Questionnaires, Adrenal and Lung, to complete the core functionality of this project. Additionally, our team studied the related information described in www.healthit.gov site to better understand where the health organization initiatives are headed and how they should be incorporated into our project. Much of the effort in the project was related to understanding the technical details related to the XSLT and HTML, which are core to supporting the generation of HTML web forms for any FHIR HL7 compliant Questionnaires. We used the Altova Style Vision tool (https://www.altova.com/stylevision.html) for early experiments to generate XSLT files, as well as, validating our source Questionnaires and generated Questionnaire Response files against the FHIR HL7 data schemas. We utilized the tutorials at https://www.altova.com/aot/online-training.html to learn how to properly utilize the Altova tools.

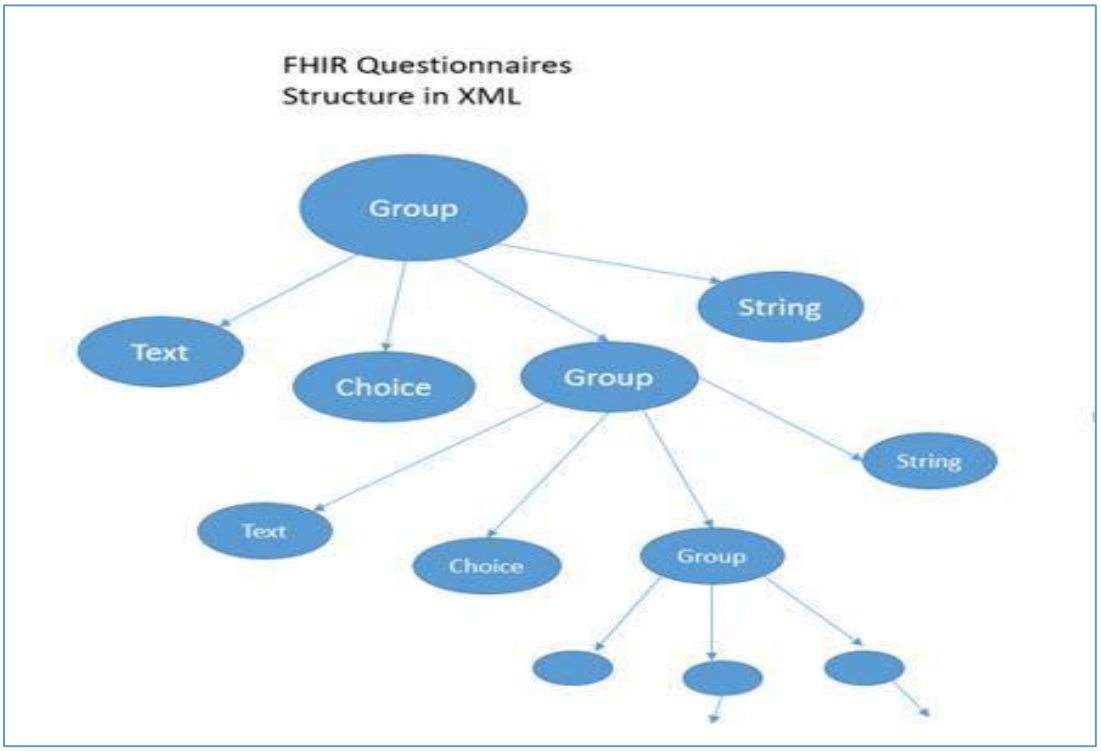
Workflow and System Design

For our design, we determined to create a Form Manager to store Questionnaires in the FHIR HL7 XML format. A simple Client HTML interface would be provided to enable the user to select existing forms to complete. The system would use standard JavaScript and XSLT to generate Questionnaire/Response XML output compliant with the FHIR HL7 standard that could be transmitted to a State Cancer Registry

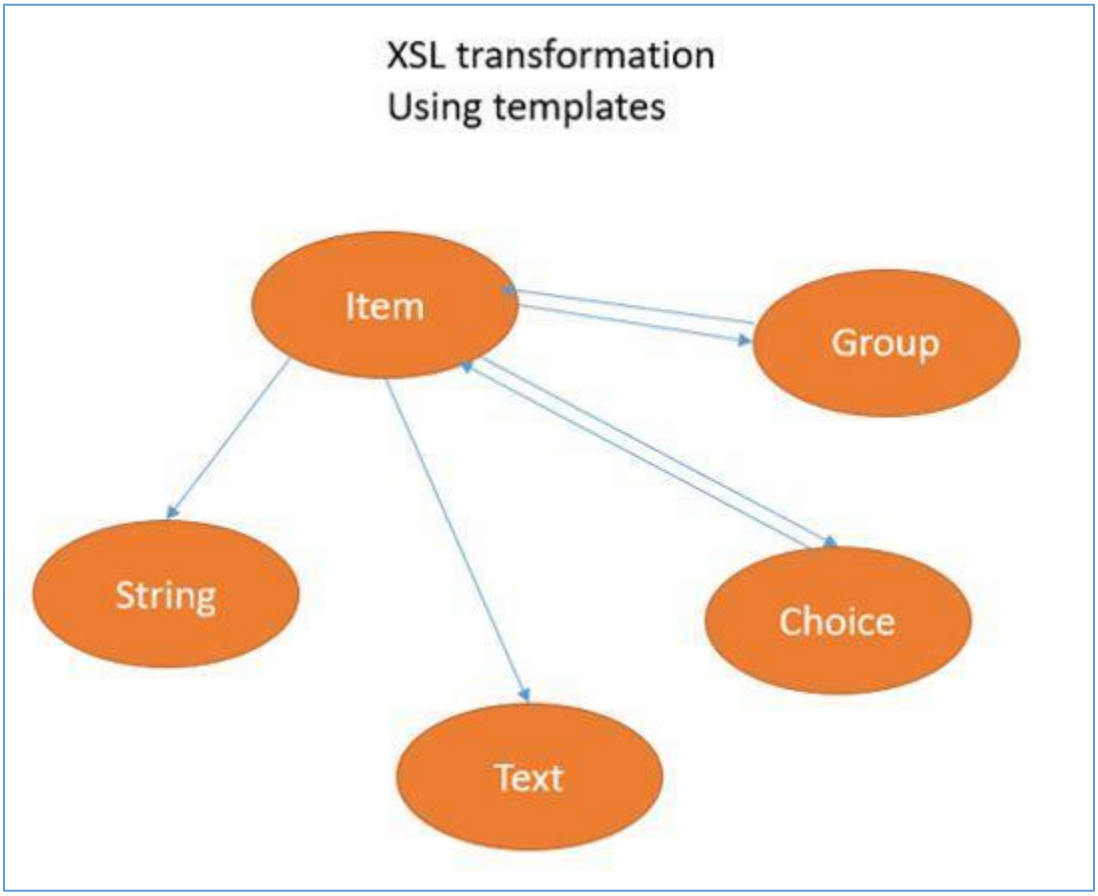
Our web page displays the available Questionnaire form selections, which the technician can choose from and to generate QuestionnaireResponse output that could be submitted to State Cancer Registries. In order to complete the process, the web browser requests the selected XML data from FHIR repository. The FHIR repository will send the XML data to HTML converter, where it uses a specifically crafted XSLT document to build the HTML web pages from the XML data. The technician will be able to fill out responses in the HTML form online. As soon as the technician click ‘submit’ button, the XML format of the Questionnaire Response will be populated and can be copied and sent to State Cancer Registry.



We determined that the FHIR HL7 Questionnaire schema was composed of a hierarchy using the value "group" as the top level descriptor with "text", "string", and "choice" as sub values. The next "group" value is also nested in the higher level "group" value.

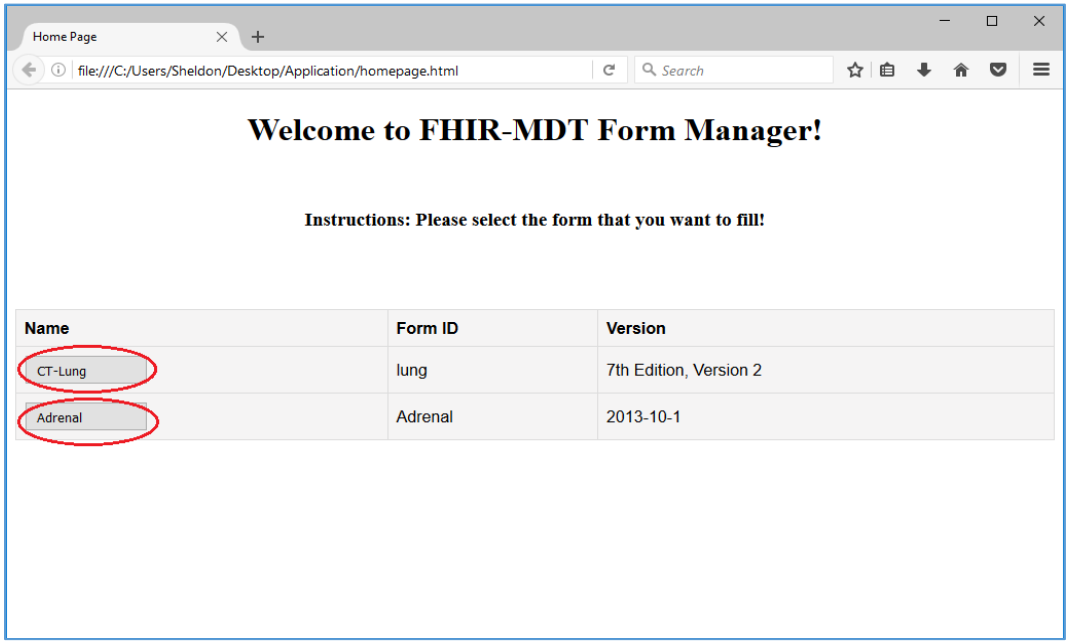


From these original questionnaires, we created XSL templates to perform the transformation through recursive calls. Using this method, we were able to create standard forms that allowed us to create questionnaires with the appropriate questions and response types including drop boxes with pre-filled options, and text boxes. Once completed the forms will return the appropriate data in the FHIR XML format.

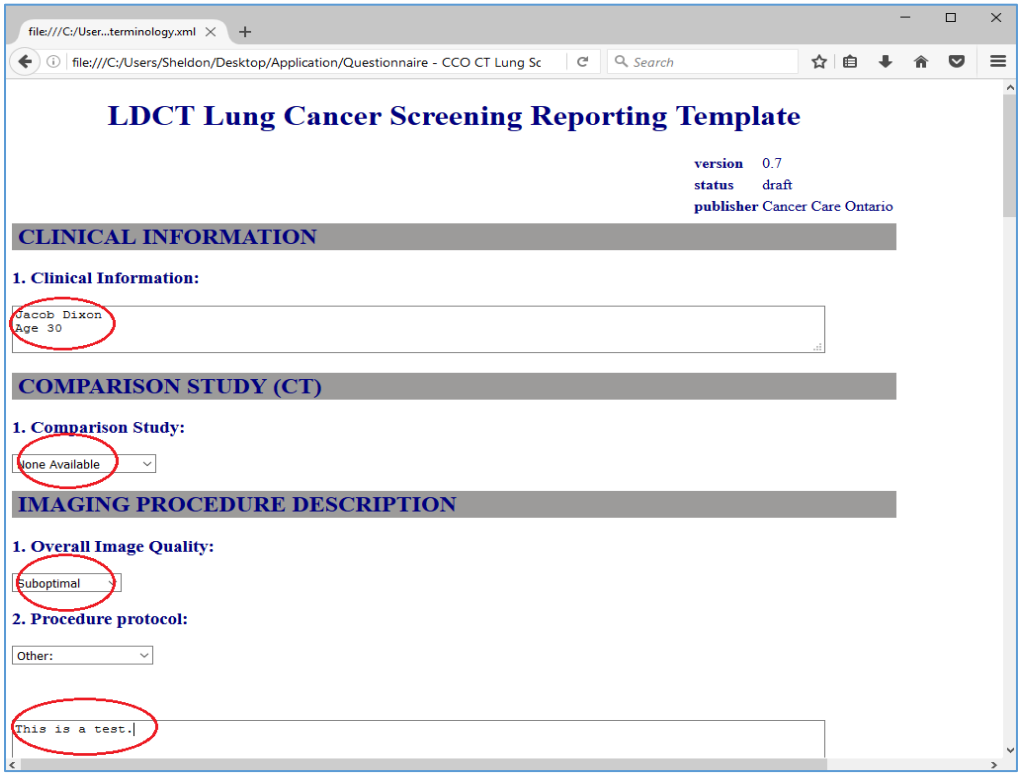


User Interface

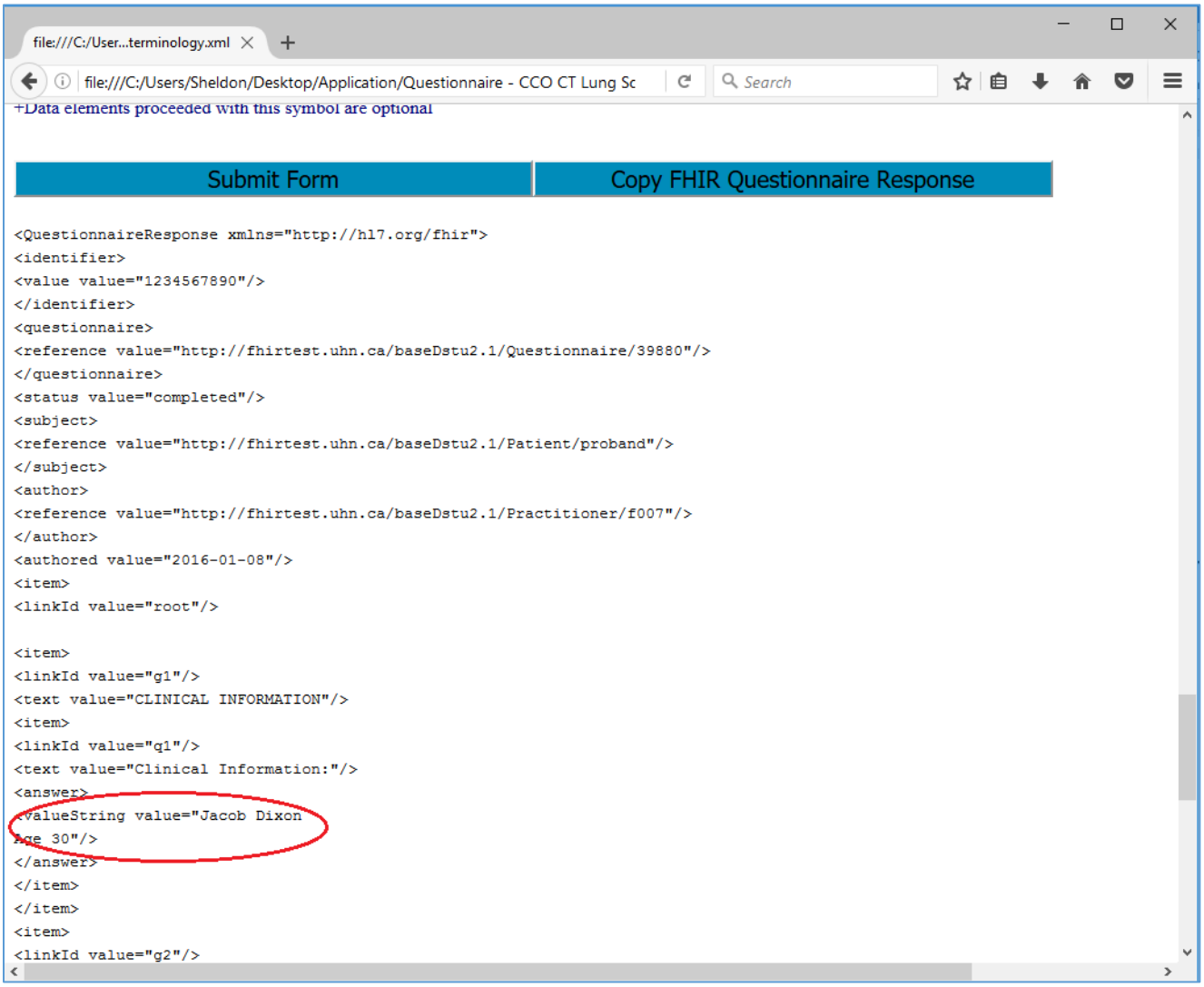
Below is the screenshot of the user interface for the user to choose a report to complete:



Below is a questionnaire rendered as an HTML web form:

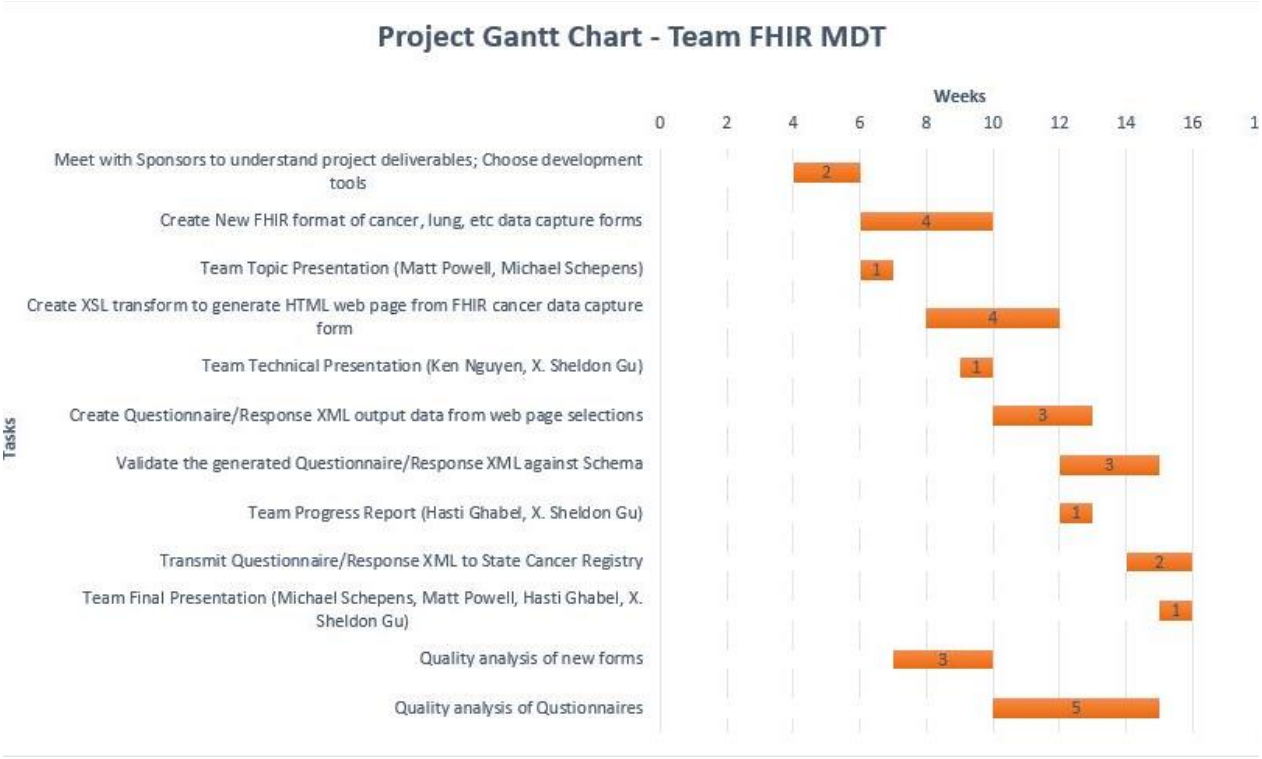


Below is the generated QuestionnaireResponse xml results for the filled out form:



Project Plan

The below Gantt chart shows the workflow of our project and team members' responsibilities.



Observations

We originally thought we could use a tool called Altova Stylevision to simplify the creation of the XSLT transforms. However, we encountered technical limitations and complexities with learning advance features of the tool. For this reason, we decided to code the XSLT manually. We did use the Altova tool to validate compliance of our generated XML files against the FHIR HL7 schemas. While researching the structure of the Questionnaire schemas, we observed that the standard supported an indefinite level of question hierarchies. Additionally, the standard supported follow up responses conditional to primary responses. This design of the schemas supported sophisticated questionnaire forms; however, it also increased the complexity of implementation for these forms. This was a clear representation of the tradeoff between coverage and complexity which could increase the challenge of getting successful implementations of tools. Additionally, the data content of individual specific questionnaires could contain sensitive internal cross reference values and conditional answers. This complexity of data increases the difficulty of updating and maintaining accuracy of individual questionnaires as they evolve.

Conclusion

We succeeded in producing two sample Questionnaires, Lung and Adrenal, compliant with the current FHIR HL7 standard. We completed a template based XLST transform file that created working HTML web forms for any FHIR HL7 complaint Questionnaire. This allows the user to fill in answers for the selected form. Finally, we were able to produce the output XML compliant with the FHIR HL7 Questionnaire/Response schema. This data is in the correct format which could be transmitted to a State Cancer Registry system implementing the same FHIR HL7 standard.

References

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