Use of HL7 FHIR as eSource to Pre-populate CDASH CRFs using a CDISC ODM API

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This Project Extends the Initial Research on FHIR (RoF) Project

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Paper RW04

Use of Fast Healthcare Interoperability Resources (FHIR) in the Generation of Real World Evidence (RWE)

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Consider reading the papers in order if you are new to eSource and HL7 FHIR
Initial Research on FHIR (ROF) Project

• Extracted data for diabetic type 2 patients from the MITRE SyntheticMass Synthea Health Information Exchange (HIE)
• Mapped certain data points to CDASH & SDTM
• Generated CDASH-compliant CRFs
• Generated SDTM-compliant datasets
• Ran across a few needed tweaks to FHIR, CDASH & SDTM
• Realized further exploration & more work is needed
Current RoF Project Purpose

• Automates the EHR data retrieval approach used in the initial Research on FHIR (RoF) paper

• Provides a model for retrieving EHR data, converting it to CDISC standards, and loading it in a CRF

• Demonstrates how data standards, workflows, and APIs reduce eSource implementation barriers

• Demonstrates the use of HL7 FHIR as an eSource technology that can be used with the CDISC standards

• Extends the CDISC standards to better support eSource
FHIR Highlights

- EHR standard accepted **globally**
- Truly **interoperable** – can be used on any system
- Machine & **human** readable
- Can **query** for specific data points
- Uses **RESTful APIs** to exchange data
- Extensible
- **Hierarchical** metadata structure – **better organized**
- Data organized as **Resources**
- Resources can be **combined**

https://www.hl7.org/fhir/
FHIR Resources

Clinical Resources

General
- AllergyIntolerance 3
- Condition (Problem) 3
- Procedure 3
- ClinicalImpression 0
- FamilyMemberHistory 2
- RiskAssessment 1
- DetectedIssue 1

Medication & Immunization
- Medication 3
- MedicationRequest 3
- MedicationDispense 2
- MedicationStatement 3
- Immunization 3
- ImmunizationRecommendation 1

Care Provision
- CarePlan 2
- Goal 2
- ReferralRequest 1
- ProcedureRequest 3
- NutritionalOrder 3
- VisionPrescription 1

Diagnostics
- Observation 5
- DiagnosticRequest 3
- ProcedureRequest 3
- Specimen 2
- BodySite 2
- ImagingStudy 3
- ImagingManifest 1

Smallest logically discrete units of “transaction of interest” to healthcare

https://www.hl7.org/fhir/resourcelist.html
RoF Adapter Prototype

RESEARCH ON FHIR ADAPTER FOR PRE-POPULATING CRFS
EHR Server: HSPC + Synthea Data

About Synthea

Synthea is a Synthetic Patient Population Simulator that is used to generate the synthetic patients within SyntheticMass. Synthea outputs synthetic, realistic (but not real) patient data and associated health records in a variety of formats. Read our wiki for more information.
### StudyEvent

<table>
<thead>
<tr>
<th>Method</th>
<th>URI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/studyevents</td>
<td>Creates a new StudyEvent</td>
</tr>
<tr>
<td>GET</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/studyevents</td>
<td>Returns the list of StudyEventDefs</td>
</tr>
<tr>
<td>GET</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/studyevents/{studyEventOID}</td>
<td>Returns the StudyEventDef and a list Form references</td>
</tr>
<tr>
<td>PUT</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/studyevents/{studyEventOID}</td>
<td>Update a StudyEvent</td>
</tr>
<tr>
<td>DELETE</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/studyevents/{studyEventOID}</td>
<td>Removes the StudyEventDef</td>
</tr>
</tbody>
</table>

### Form

<table>
<thead>
<tr>
<th>Method</th>
<th>URI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/forms</td>
<td>Creates a new Form</td>
</tr>
<tr>
<td>GET</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/forms</td>
<td>Returns the list of FormDefs</td>
</tr>
<tr>
<td>GET</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/forms/{formOID}</td>
<td>Returns the FormDef and the associated list of ItemGroupRefs</td>
</tr>
<tr>
<td>PUT</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/forms/{formOID}</td>
<td>Update a Form</td>
</tr>
<tr>
<td>DELETE</td>
<td>/studies/{studyOID}/mdv/{mdvOID}/forms/{formOID}</td>
<td>Removes the FormDef</td>
</tr>
</tbody>
</table>
Open, Standard APIs Improve Scalability of Data Exchange Solutions
Increasing Open, Standard APIs

- RoF Adapter demonstrated the use of current and future open, standard APIs
  - HL7 FHIR API
  - ODMv2 API
  - SHARE API v2.x (working on becoming more open)
- Provide on-demand access to the source of truth
- Drives automation and the standardization of data
RoF Adapter eSource Process

Use the ODM metadata to build a FHIR request to retrieve EHR content to prepopulate the associated EDC variable.

```
<ItemDef OID="ODM.IT.VS.TEMP.VSORRES" Name="Temperature" DataType="float">
  <Description>
    <TranslatedText xml:lang="en">Result of the vital signs measurement as originally received or collected.</TranslatedText>
  </Description>
  <Question>
    <TranslatedText xml:lang="en">Temperature</TranslatedText>
  </Question>
  <Alias Context="CDASH" Name="TEMP.VSORRES"/>
  <Alias Context="CDASH/SDTM" Name="VSORRES+VSORRESU"/>
  <odmv2:Origin Type="Collected" Source="Investigator">
    <odmv2:FHIR Resource="Observation" Attribute="valueQuantity.value"/>
  </odmv2:Origin>
</ItemDef>
```

LOINC Code  FHIR Resource  FHIR Attribute
EDC eSource Mapping Metadata

Research On FHIR eSource: Retrieve Study Metadata
Study ID: 16676
FHIR Endpoint: https://api-stu3.hspsconsortium.org/phusefhir/open/

Register Study and Retrieve Study Metadata

URL to Retrieve EDC Metadata
http://127.0.0.1:8080/odm1-3-2-api/

Study OID
16676

Username
Tom Swift

Password

Load Study Metadata

Metadata
- ODM.IT.IB.LBDTC FHIR:Observation.effectiveDateTime
- ODM.IT.IB.WBC.VSORRES FHIR:Observation.valueQuantity.value
- ODM.IT.IB.WBC.LBORRESU FHIR:Observation.valueQuantity.unit
- ODM.IT.IB.ALB.VSORRES FHIR:Observation.valueQuantity.value
- ODM.IT.IB.ALB.LBORRESU FHIR:Observation.valueQuantity.unit
- ODM.IT.IB.GLUC.VSORRES FHIR:Observation.valueQuantity.value
- ODM.IT.IB.GLUC.LBORRESU FHIR:Observation.valueQuantity.unit
- ODM.IT.IB.HBA1CHGB.VSORRES FHIR:Observation.valueQuantity.value
- ODM.IT.IB.HBA1CHGB.LBORRESU FHIR:Observation.valueQuantity.unit
- ODM.IT.IB.ALCREAT.VSORRES FHIR:Observation.valueQuantity.value
- ODM.IT.IB.ALCREAT.LBORRESU FHIR:Observation.valueQuantity.unit
- ODM.IT.CM.CMTRT FHIR:Medication.display
- ODM.IT.CM.CMDOSE FHIR:MedicationStatement.dosage.doseQuantity.value
- ODM.IT.CM.CMDOSFRQ FHIR:MedicationStatement.dosage.timing
- ODM.IT.CM.CMROUTE FHIR:MedicationStatement.dosage.route

Select Study  Register Study  Transfer Data
Initiate EHR Patient Data Transfer

Research On FHIR eSource: Retrieve EHR Data and Post to EDC System

Study ID: 16676
FHIR Endpoint: https://api-stu3.hspconsortium.org/phusefhir/open/

Retrieve EHR eSource Data and Post to EDC System

StudyEvents
Baseline Visit (BASELINES) Scheduled

EHRDate

VisitDate
2018-02-12

Patients
Subject SK-0002 - Patient Frank Taylor (SMART-1627321)

Metadata
Collection Date and Time (ODM.IT.LB.LBDTC)
WBC (ODM.IT.LB.WBC.VSORRES)
WBC Units (ODM.IT.LB.WBC.LBORRESU)
ALB (ODM.IT.LB.ALB.VSORRES)
ALB Units (ODM.IT.LB.ALB.LBORRESU)
Glocose (ODM.IT.LB.GLUC.VSORRES)
Glocuse Units (ODM.IT.LB.GLUC.LBORRESU)
Hemaglobin (ODM.IT.LB.HBA1CHG.VSORRES)
Hemaglobin Units (ODM.IT.LB.HBA1CHG.LBORRESU)
Albumin/Creatinine (ODM.IT.LB.ALBCREAT.VSORRES)
Albumin/Creatinine Units (ODM.IT.LB.ALBCREAT.LBORRESU)
Medication or Therapy (ODM.IT.CM.CMTRT)
Dose (ODM.IT.CM.CMDOSE)
Frequency (ODM.IT.CM.CMDOSFRQ)
Route (ODM.IT.CM.CMROUTE)

Transfer EHR Data
EHR Patient Data Transferred to EDC Server

Research On FHIR eSource: Data Transferred from EHR to the EDC System

Study ID: 16676
FHIR Endpoint: https://api-stu3.hsconsortium.org/phusefhir/open/

Data Transferred from EHR to the EDC System

Data transfer successfully completed.
Data transferred from 1 patients.
29 EDC data fields pre-populated with EHR data for each subject.
Data transferred to EDC visit date 2018-02-12
Future CDISC Developments Piloted in this Project

• ODMv2
  – API
  – ODM in JSON
  – FHIR mapping metadata
  – Formalized semantics (e.g. LOINC and SNOMED-CT)

• CDASH
  – Extended to include E2C FHIR mapping metadata for select variables

• SHARE API v2.x
  – Retrieve CDASH FHIR mappings in ODM using the SHARE API
Extend CDISC End-to-End Standards to include eSource

### CDISC Standards in the Clinical Research Process

<table>
<thead>
<tr>
<th>Pre-Clinical</th>
<th>Common Protocol Template</th>
<th>Collection</th>
<th>Tabulation</th>
<th>Analysis</th>
<th>Submission Publication Reporting</th>
<th>New Treatment for Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tabulation</strong></td>
<td><strong>PRM</strong></td>
<td><strong>SEND</strong></td>
<td><strong>CDASH</strong></td>
<td><strong>SDTM</strong></td>
<td><strong>ADaM</strong></td>
<td><strong>TRANSPORT</strong> Define-XML Dataset-XML</td>
</tr>
</tbody>
</table>

**TRANSPORT** ODM-XML SDM-XML

**TRANSPORT** ODM-XML

**TRANSPORT** Define-XML Dataset-XML

BRIDG, CONTROLLED TERMINOLOGY AND GLOSSARY
Pilot RoF Adapter Limitations

- Used basic mechanisms for slotting EHR data into the EDC visit structure
  - Visit type
  - EHR and visit dates

- Resource substitution for resources missing in the EHR

- No automated terminology mapping

- Uses draft versions of new standards
RoF Discussion Topics Warranting Additional Attention in Future Projects

• Healthcare / research terminology differences
• Visit vs. visitless (longitudinal) studies
• Test environment to limit mapping / data issues
• Determining which fields use eSource content
• Consent and privacy rules
Want to get involved?

Contact
Trisha Simpson Trisha.Simpson@UCB.com
Lauren White laurenwhite@phuse.eu

The premier community for people working in the biometric area

Thank You!